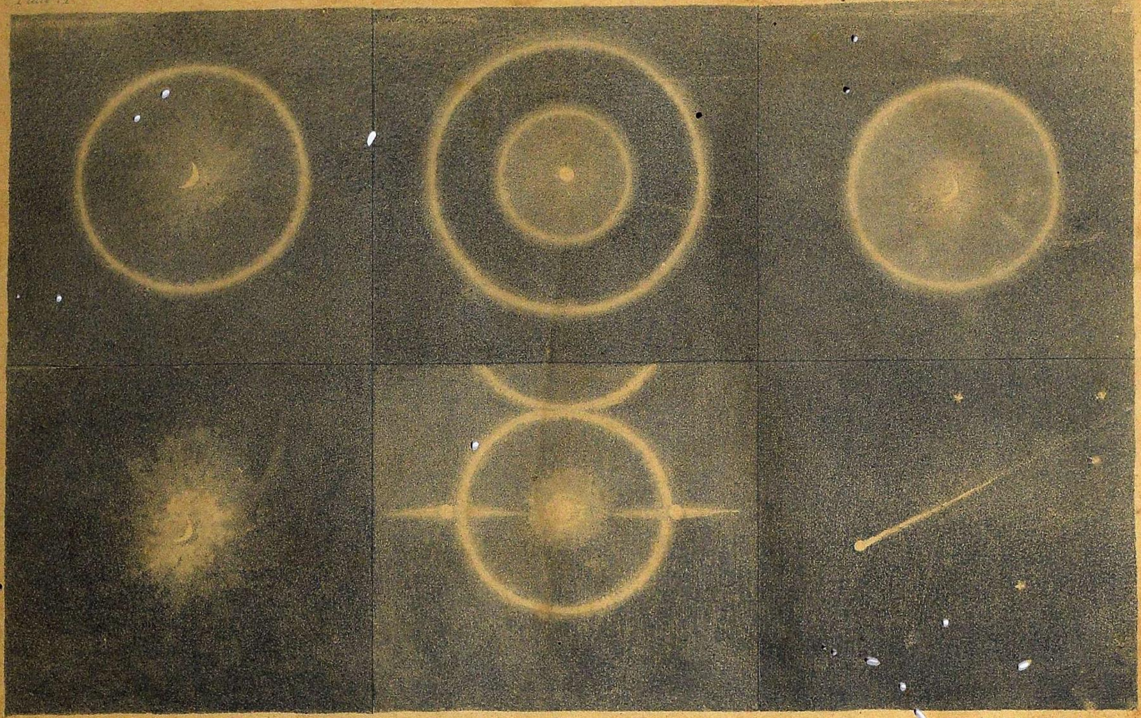

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Sarfajiu Rajah 1930

RESEARCHES

ABOUT

ATMOSPHERIC PHAENOMENA.

BY

THOMAS FORSTER, F. L. S.

SECOND EDITION,

CORRECTED AND ENLARGED;

With a Series of Engravings illustrative of the Modifications of the Clouds, &c.

ΕΣΤΙΝ. ΑΝΘΡΩΠΟΙΣ. ΑΝΕΜΩΝ. ΟΤΕ. ΠΛΕΙΣΤΑ.
ΧΡΗΣΙΣ. ΕΣΤΙΝ. Δ' ΟΥΡΑΝΙΩΝ. ΥΔΑΤΩΝ.
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PREFACE

TO

THE SECOND EDITION.

AMONG the many erroneous views which people take of the origin of the sciences, no one appears more common than that of supposing that they have all been originally undertaken and pursued with some particular aim to public or individual utility; as if the investigation of nature was not valuable; nor natural phaenomena capable of exciting us to the pursuit of their causes, on account of the pleasure they produced in engaging the energies of our different intellectual faculties, independently of any further purpose to which they might be made subservient. Some imagined object of utility, for the attainment of which people consider the different sciences as valuable, has generally been supposed to be the cause which has impelled mankind to follow them, as if from feeling certain exigencies arising from time to time out of the pro-

gressive civilization of society, men had been taught to love the pursuit of knowledge and the exercise of reflection, by the imperious calls of newly created wants. This is a very old opinion. People too, having confounded the causes of excitement existing around us in the world with the various faculties of the mind to be excited, have even supposed that our propensities, sentiments, and our intellectual and reflecting powers have been derived from education; and that from the contingent circumstances of different individuals have arisen the varieties of the human character; without reflecting on the infinite variety of organization observable in individuals throughout the creation, and without ever perceiving that unless there were conditions in ourselves of the different manifestations of the mind, the objects around us could never excite, nor education ever improve our several faculties. I have always believed that there were differences in the native structure of persons which independently of, though perhaps modified by, early habits and associations, have inclined them naturally to the pursuit of different branches of science. And, I think, the recent investigations of modern physiologists will verify this opinion, and will

demonstrate the material conditions necessary to the multiform manifestations of the mind.

People having the idea that every thing is valuable for some secondary object; this object to which an imaginary value is attached varies in the minds of different persons, according to their own particular conformation of mind and to their education. In many, the aggrandizement of property being the prevailing passion, scarcely any thing is considered useful, except that which contributes to public or private wealth. In others, the degree in which any science or art can contribute to common convenience, or abridge labour, becomes the measure of their estimation of it. Judging of others by themselves, people have supposed that the sciences have always been cultivated for such secondary reasons, and that in the early stages of society, they arose out of the numerous artificial wants which advancing civilization was continually producing. But though it has generally been the case with the multitude who have followed up the discoveries of the ingenious, that availing themselves of the intellect of their superiors, they have erected a trade on their inventions, or have converted them to purposes of social improvement; yet many of those phi-

losophers, to whom society has been indebted for the most important improvements in the sciences, have cultivated them originally for the sole pleasure which the pursuit itself afforded. There have been in all ages, persons who have taken delight in observing and comparing natural facts, and for whose philosophic minds the infinite variety exhibited by all natural objects, and the investigation of the respective causes of different phaenomena, are of themselves sufficient to engage them in the pursuit of science, and the knowledge obtained thereby an adequate reward for their labours.

In the earliest ages, as far back as history enables us to trace the operation of the human intellect, we find mankind interested about meteorological phaenomena. A circumstance by no means astonishing, when we consider the vast importance of this science to the shepherd and agriculturist, and the interest the study of it engaged, as a means of enabling men by anticipating the event of terrible atmospheric commotions, to provide in some measure against their effects. The beauty, also, of many atmosperic phaenomena, and the interesting variety of scenery which they produce for the spectator; together with the natural curiosity excited about their causes, which man is organized to

feel, have contributed probably in a great measure to interest people in this science.

Meteorology considered as a subject of amusement seems to have some advantages over many other pursuits; inasmuch as it may be studied and will afford interest in places unfavourable to the cultivation of other sciences. The botanist, who delights in the diversification of nature exhibited in the endless variety of the forms and colour of flowers; or the naturalist, who finds amusement in contemplating the habits of animals, and the adaptation of the structure of each to its mode of life, cannot indulge their inclination except in habitable countries, or where vegetation and life abound. But on the barren mountain's rugged vertex, in the uniform gloom of the desert, or on the trackless surface of the ocean, we may view the interesting electrical operations which are going on above, manifested in the formation and changes of the clouds, which bear water in huge masses from place to place, or throw it down in torrents on the earth and waters; occasionally creating whirlwinds and waterspouts; or producing the brilliant phaenomena of meteors and of lightning; and constantly ornamenting the sky with the picturesque imagery of coloured clouds and golden haze.

The atmosphere and its phaenomena are every where, and thunder rolls, and rainbows glitter in all conceivable situations, and we may view them whether it may be our lot to dwell in the frozen countries of polar ice, in the mild climates of the temperate zone, or in the parched regions which lay more immediately under the path of the sun.

Among the ancient nations of oriental shepherds, the cultivation of this science must have been particularly useful; chemistry and many other sciences which are necessary to the promotion of a more cultivated condition of society, for the improvement of the arts, and manufactures of civil life, were of less utility among tribes, whose chief employment consisted in watching their flocks, and procuring the fruit and other vegetable productions on which they subsisted.

Constantly abroad in a serene atmosphere, and endowed with strong faculties for observation and analogy, the eastern tribes of old, in Aegypt and Syria, observed accurately the phaenomena of the heavens, and collected, compared, and recorded, facts that laid the foundation of astronomy and meteorology, which the Grecian and Roman philosophers continued to cultivate, and which have

been brought nearer to perfection in later times.

Meteorology, regarded as a science distinct from astronomy and astrology, appears to have been first systematically treated of by Aristotle, who seems by his works to have been constantly employed in observing and comparing natural objects. He described with accuracy many atmospheric phaenomena, and employed himself in investigating their causes. He assigned the cause of the rainbow, and of the halo, and appears to have given a more minute detail of the various appearances of clouds, rain, hail, snow, dew, meteors, and other phaenomena which occur in our air than any preceding or cotemporary writer. Shortly after him Theophrastus, who had been his pupil, collected all the popular prognosticks of the weather, under four heads; 1, Περι σηματων υετων; 2, Περι σηματων ἄνεμων; 3, Περι σηματων χειμωνων, and 4, Περι σηματων ἐυδίων: these prognosticks Aratus soon embodied in his Diosemea, which was a sort of appendix to his astronomical poem the Phaenomena, translated into Latin verse by Cicero, by Germanicus, and by Festus Avienus. We find meteorological observations interspersed in the writings of the Greek historians; and the frequent allusion to atmospheric phae-

nomena by their poets shows the attention which was generally paid to such subjects. The simplicity and correctness of narration adopted by the Greeks was probably the result of the prevailing perfection of their physical organization which is one of the principal conditions of intellectual excellence, and in which their philosophers excelled most of those of more modern times. The heads of the ancient Greek philosophers are of a remarkably fine form for intelligence.* The Romans who wrote on meteorology of any note were Pliny, who in his Natural History, lib. xviii.

* The heads of many of the Roman philosophers, and indeed of those of all countries, ancient and modern, did certainly, as well as those of the Greeks, refute Juvenal's satyrical assertion *fronti nulla fides*, if he ever really intended such as a serious observation; but the configuration of the heads of those celebrated ancient nations, who gave birth to the sciences from the native energies of their intellectual faculties, is more particularly calculated to illustrate and confirm the notions of modern physiologists respecting the intimate connection between the physical strength of the organs of the brain and the intellectual and moral character of the individual. A subject which has been ably treated of by the celebrated anatomists, Gall and Spurzheim, who by their elegant dissections of the brain, and their comparison of the brains of different animals with the proper habits of each, seem to have roused comparative anatomy into something like a systematick science. Dr. Spurzheim has just published a large work on this important science, The Anatomy and Physiology of the Brain.

cap. 35, wherein he treats of the prognosticks of the weather, confounded his observations with abundance of fabulous and absurd narrations; Virgil, who in his Georgics imitated the prognosticks of Aratus; Lucretius, who endeavoured to assign physical causes for most of the popular phaenomena of the heavens; and, lastly, Seneca, with whose superfluous tautology in his Natural Questions, every one who has read them must have been heartily tired. In the works too of many of their other writers we find traces of their meteorological knowledge. It is a pity we know so little of the collateral history of this as well as of the sciences among the Chinese and Arabians; and among other eastern tribes of the present day.

Little account of the state of our science can be traced from the time of the ancient Romans to the revival of letters in Europe; and it was not till the middle of the last century that any advancement was made in meteorology. During the dark ages which elapsed between the decay of the Roman Empire and the revival of literature; when the works of art and science again fell a prey to superstition and barbarity, and when the enlightened philosophers of Greece and of Rome resigned their pre-eminence in the republick of letters, and gave

way to a loathsome band of crafty and overruling zealots, who being themselves the sport at once of pride, of craft, and of superstition, exerted the full force of their assumed power to enslave the minds of the already degenerate race of the people, and to banish from them all vestiges of literature and of philosophy; at this disgraceful period which is a blot in the natural history of the human species, meteorology like every other science perished, and all the observations and records of former observers were forgotten. But the stream of time is a fluctuating torrent, and intellectual excellence seems to flourish at alternate periods. Shortly after learning again began to flourish, and the energies of the human mind again exerted themselves according to the particular genius of individuals, there appeared persons who delighted in aërial phaenomena, and Saussure De Luc, Bertholon, and others at length roused the attention of mankind to the production of our atmosphere. The attention of philosophers since their writings seems more particularly to have been directed to these subjects, which can only be brought towards perfection by the repeated observations of people in different places. To add what few I have made myself, and to engage the attention of

more able and industrious meteorologists to some facts in the science at present little known, is the reason of the present publication.

In conclusion of this rude sketch of the science from its earliest records to the present day, we are naturally led to reflect on the melancholy picture of the revolution of human society, which the history of almost any science or art will always excite. Science seems to have illumined first the banks of the Nile, and to have dawned on the early tribes of Aegypt; travelling down from Thebes to Memphis and Cairo, it took a westerly course to Athens, to Rome, and to the many illustrious states which afterwards distinguished modern Europe. But in tracing her progress we find nothing left in her course, but the skeleton of former greatness. The ruins of stupendous cities once the ornament of the east; the numerous fortifications, walls, temples, aqueducts, and other works of art, now nothing but the desolated habitations of wild animals, and the traces left of sciences which, like fruitless flowers, bloomed in the spring of time only to decay, are monuments of human fatality which must impress reflecting persons with gloomy notions of the instability of society, and incline us to fear that, in spite of all the

efforts of genius and of art of modern times, the light of knowledge which rose in the east, and civilized the oriental nations, will set on the western parts of the world, and leave us ere long a monument to future ages of the fluctuating nature of human perfection, unless by a strict attention to the improvement of the physical organization of our species, conjoined with the adoption of some general plan of education superior to any hitherto enforced, we should permanently improve the moral and intellectual character of future generations; without which all the scientific records imaginable would be to them only as cyphers scrawled on the barrenness of intellect.

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CHAPTER I.

OF MR. HOWARD'S THEORY OF THE ORIGIN AND MODIFICATIONS OF CLOUDS.

A cloud is a visible aggregate of minute particles of water suspended in the atmosphere. In the more extensive signification of the word, smoke, and all the visible effluvia of volatile substances, may be considered as clouds: meteorologists have, however, confined this term to aqueous particles.*

* Our English word *cloud* is derived of the Anglo-Saxon verb hliðan or Ᵹehliðan, *tegere*, to cover; from the same verb came *glade*, *blot*, *lot*, and *lid*. In like manner, the Latin *nubes*, and its diminutive *nebula*, came from the Latin verb *nubere*; and from the same verb is derived *nupta*. So the Greek νεφος and νεφελη from νεφεον. It need hardly be observed here, that all

Before I speak of the origin, suspension, and varieties of clouds, and of their destruction by rain, some preliminary observations will be necessary. Aqueous particles, and other volatile substances, may be either diffused in the air, or may be dissolved in it. But diffusion and solution are things quite different from chemical combination.

A cloud may either be so diffused as to cease to be visible as an aggregate, or it may be taken into solution by the air: in the former case, a hazy turbidness; in the latter, an additional clearness of the sky; would probably be the consequence.*

that words can do, is to express some of the qualities of the thing they represent; they serve merely as hints for the production of ideas.—See Tooke's Επεα Πτεροεντα, 4to. vol. ii. 196.

* A cloud may be the consequence of vapour, upraised into the air, and afterward more condensed into visible particles, by an alteration either in the temperature or pressure, whereby the air cannot hold so much vapor in solution as before. Some recent discoveries have, however, led to a supposition that, under particular circumstances, the air itself may be decomposed so as to deposit water, which may again be taken up by the air. Thus we come back again to the old opinion of Aristotle: Ει δὴ γίνεται υδωρ εξ αερος καὶ ἀὴρ εξ ὕδατος δια τινα ποτ' αἰτιάν ου συνισαται νεφη κατα τον ἄνω τοπον, &c.—*Meteor*. lib. i. cap. 3.

I speak first of clouds, because in the observance of the varying countenance of the sky, as Mr. Howard terms it, and of its connexion with atmospheric changes, consisted the popular meteorology of the ancient agriculturists, who were chiefly concerned to inquire

> Quo signo caderent austri, quid saepe videntes
> Agricolae proprius stabulis armenta tenerent.

And the accuracy of their observations, with respect to prognostics of the change of weather, have been verified by those of more modern meteorologists. It is obvious, however, that the ancients wanted definite terms whereby to express the peculiarities observable in clouds and other atmospheric phaenomena; a deficiency which has been in some degree supplied by the moderns, and particularly by Mr. Howard, whose theory of the formation and destruction of clouds appears, as far as I am capable of judging, to be extremely accurate in most particulars. As it will be necessary for me to have perpetual reference to this theory, and as I shall always use the terms which he has adopted, it will be proper to present the reader with

the substance of it, as nearly as I can recollect it, with such additional observations as I have been enabled to make since, together with references to those passages in the writings of the ancients which appear to bear upon the subject.

I shall not pretend, however, to give exactly Mr. Howard's observations, but only an abstract of the principal facts, as far as they immediately relate to the origin and appearances of the clouds; for further particulars, I refer the reader to the original paper printed in the *Philosophical Magazine.*

SECTION I.

Of the artificial Distinction of Clouds.

CLOUDS are distinguished by seven modifications, the peculiarities of which seem to be caused by the agency of electricity: for example, three primary modifications, the CIRRUS, the CUMULUS, and the STRATUS: two, which may be considered as intermediate in their nature, the CIRROCUMULUS, and CIRROSTRATUS; one, which

appears to be a compound, the CUMULO-STRATUS; and, lastly, the CUMULOCIRRO-STRATUS, or NIMBUS, a state which immediately precedes the resolution of clouds into rain.

SECTION II.

Of the Cirrus. Pl. I. Fig. 1.

CIRRVS. Def. NVBES CIRRATA TENVISSIMA QVAE VNDIQVE CRESCAT.

THE cirrus is a cloud which appears to have the least density, and generally the most elevation, and which has the greatest variety of extent and direction. It may truly be called the Proteus of the skies; for, in some kinds of weather, its figure is so rapidly and so continually changed, that after turning the eye away from it for a few minutes, it will frequently be found so completely altered as scarcely to be identified as the same cloud. This, however, is not always the case; it is sometimes visible for many hours and even days together, without much changing its appearance. I shall briefly mention some of its most common varieties, together with

the circumstances under which they generally appear.

After a continuance of clear weather, the cirrus is frequently the first cloud which is seen. In this case it often looks like a fine whitish thread pencilled, as Mr. Howard expresses it, on the clear blue sky: to this other faint lines of the same kind are added laterally; they increase in size and length, and often serve as stems from which numerous branches proceed, and become other cirri of the same kind. These linear cirri will generally be found to be very high in the air, the lines frequently extend quite across the welkin, while their ends, being lost in either horizon, appear, from a well known optical deception, to converge into one point. They do not always extend in parallel lines; they frequently diverge, or increase obliquely downwards. Sometimes transverse lines are formed, which intersecting the others at right angles, give to the sky the appearance of being covered with a beautiful network. Of late, by way of distinction, I have used certain specific names for the various forms of each modification. I have called this netlike feature the reticu-

lar cirrus. Those which are local and detached, and which ramify in many directions, giving the idea of a distended lock of hair, may be denominated comoid cirri. Sometimes numerous little filaments appear like bundles of thread, which I have called filiform cirri. In fair, dry weather, with light gales, obliquely descending bands of fibrous texture are often seen, and frequently move slowly along from the leeward in a supervening current. I by no means intend, by the above account, to infer that the appearances of the different kinds of cirri, or indeed of any cloud, are ever quite uniform; on the contrary, scarcely two occur exactly alike; and there are many features so various and so mixed, that a particular description of each can scarcely be attempted. In some kinds of weather, the numberless and ever changing figures which this cloud is continually presenting to the eye, baffle all attempt at description. Practical observation affords the only means of becoming acquainted with them.

The observations of Mr. Howard, as well as those which I have made since the perusal of his meteorological papers, have induced me to believe, that, under whatever

form the cirrus may appear, it must always be regarded as a conductor of the electric fluid. Its very texture seems indicative of its particular office. The long parallel and elevated lines are probably equalizing the electricity of masses of air very remote from each other. The detached comoid cirri equalizing their own electricity with that of the surrounding air, while oblique or depending tufts appear to be conducting from an upper to a lower stratum. The cirrus too is sometimes interposed and conducting between two other clouds at some distance from each other. All the phenomena which I have witnessed, since my attention was directed to nepheology, are reconcileable with this supposition; and it is probable that a cirrus ceasing to conduct, ceases to be a cirrus, and that it either evaporates or passes to some of the other modifications: in doing which, it may often be seen in an intermediate state, partaking more or less of the modification into which it may be changing, and exhibiting, in the progress of its metamorphosis, very various and very beautiful appearances.

I have elsewhere had occasion to notice the long continued appearance, and the multiform and everchanging configurations of

this and the other modifications, unattended by rain, and accompanied by dry, variable, and generally easterly winds; the abundance of nocturnal meteors, and the intermitted actions of De Luc's aërial electroscope, as indicative of a very peculiar state of the electric atmosphere; and, I believe, not a very healthy one.

SECTION III.

Of the Cumulus. Pl. I. Fig. 3.

CVMVLVS. Def. NVBES CVMVLATA DENSA SVRSVM CRESCENS.

THE cumulus is a convex aggregate of watery particles increasing upwards from a horizontal base. It is commonly of a dense structure, formed in the lower atmosphere, and moving along in the current of wind which is next to the earth. Its first appearance is generally a small irregular spot, which becomes the nucleus on which it forms. This increases in size, preserves a flat horizontal base, and assumes more or less of a conical figure. Cumuli vary in shape and

dimensions, according to peculiarities in the operation of the causes which produce them. Sometimes they are pretty well defined hemispherical masses; at others, they rise into mountains, ranged in one plane, their silvery summits presenting a beautiful appearance. In particular kinds of weather I have seen cumuli of a sort of tuberculated structure. Before rain, they increase very rapidly, descend lower in the atmosphere, and become fleecy and irregular in their appearance, with their surfaces full of protuberances. In changeable weather, they partake of the vicissitudes of the atmosphere, and evaporate almost as soon as formed, or quickly change into other modifications: but, in fair and settled weather, they keep pace in some measure with the diurnal temperature, they form soon after sunrise, arrive at their maximum in the middle of the day, and become very convenient skreens to intercept the rays of the sun; and they subside in the evening. It was this circumstance which probably led to a conjecture of the particular cause of their production, which appears as follows:—The sun's rays warming first the surface of the earth, and their

radiation causing warmth to be propagated upward, this warmth converts water on the earth's surface into vapour, which rises and exerts its elastic force on that which the nocturnal decrease of temperature had not decomposed, and which therefore remained diffused. The latter, in passing through the atmosphere to give place to that from below, changes its climate, arrives in a colder air, and is thereby decomposed and thrown into a state of visible cloud. The simple attraction of aggeration may perhaps cause the watery particles to collect in a mass,* while their being similiarly electrified may render them mutually repulsive, and prevent their uniting to become rain. The cumulus preserves its plane base, because it floats on the vapour plane, or at that precise elevation at which the air has as much water in solution as from its quantum of heat and pressure from above it is able to contain. Whether the conical form of this cloud is to be attributed to the attraction of aggregation alone, or whether something particular in its

* This, however, is doubtful, as I mention in the account of the stratus.

electric state may also be concerned, has never, I think, been determined. The variation of its figure, according to different states of weather, seem to favour the latter supposition.

The cumulus, then, may either evaporate, change into the other modifications, or, by inosculating with any of them differently electrified, may form the cumulostratus, and ultimately the nimbus, hereafter to be described.

SECTION IV.

Of the Stratus. Pl. II. Fig. 4.

STRATVS. NVBES STRATA AQVAE MODO EXPANSA, DEORSVM CRESCENS.

THE stratus is the lowest of clouds; its under surface usually rests on the earth or on the water. It may properly be called the cloud of night, as it frequently makes its appearance about sunset, and disappears soon after sunrise. When ascending in the atmosphere, it often seems at a certain elevation to take the irregular hemispherical form and become a cumulus. It compre-

hends what we usually call fogs and mists, which in fine summer evenings are seen to ascend in spreading sheets from vallies, lakes, and fields. And which in autumn and winter sometimes continue throughout the day as dense fogs. It must be remembered, however, that all fogs are not strati; some appear to be of the modification of cirro-stratus. Of the latter kind are generally the wet mists which moisten every thing on which they come into contact.

In speaking of the cumulus, I have represented the manner in which elastic vapour may rise into the air, on the accession of diurnal temperature. As the sun sinks the heat also is diminished, and the lower atmosphere becomes cooler than that above. The air, no longer capable of containing so much vapour in solution as when it was warmer in the day, may deposit it in minute particles of water, which may fall in the form of mist or stratus. In the evening, too, the under atmosphere being as cold, or perhaps colder, than the upper, the vapour plane is not preserved, and cumuli by degrees may sink down in dew. Under these circumstances,

they appear often to evaporate.* This vespertine subsidence of the cumulus is a circumstance which induces me to believe that its diurnal existence, as an aggregate, is not merely the result of the attraction of aggeration. Its subsidence at a time when the general dampness of the air would afford a passage for its electricity to the earth, seems to indicate the agency of that fluid in keeping its particles collected into the hemispherical mass in which it usually appears during the day.

There are peculiarities in the appearance of the stratus, of the causes of which we are utterly ignorant. The fine mists which creep, as it were, along the vallies of a summer's evening, are generally white, and, when seen at a distance by moonlight, have a very fanciful appearance. They are strikingly contrasted to the yellow fogs of November. The stratus is found to be electrified posi-

* For further observations respecting the nocturnal evaporation of clouds, the decomposition and recomposition of the air, etc. I refer the reader to the next Chapter.

tively, and in general to be highly charged. It is proposed to examine the air above, to see whether there be found a negative counter charge.*

SECTION V.

Of the Cirrocumulus. Pl. III. Fig. 1.

CIRROCVMVLVS. Def. NVBECVLAE DENSIORES SVBROTVNDAE ET QVASI IV AGMINE ADPOSITAE.

AFTER the cirrus has ceased to conduct the electric fluid, it probably either disappears by dispersion or evaporation, or it changes into the cirrocumulus or cirrostratus. Its change to the cirrocumulus is frequently marked by the following circumstances: it looses its cirriform and fibrous structure, descends lower in the atmosphere, and assumes the form of a number of well defined and roundish little clouds, laying in close horizontal arrangement: the change is more or less rapid on different occasions, and sometimes takes place in part of the cloud, while the other part remains cirriform, or approaches to the nature of cirrostratus.

* See *Cyclopaedia*, article *Cloud*.

When the cirrus ceases to conduct, it probably becomes electrified either plus or minus, and its conversion to cirrocumulus seems to indicate that it has acquired a strong positive charge. It is difficult, however, to imagine the reason why, under these circumstances, the electrified particles should not collect into a large body like the cumulus, instead of assuming the orbicular arrangement, from which state the cirrocumulus sometimes changes again to cirrus, but more often evaporates by degrees, or passes into the compound modifications. The cirrocumulus is not always uniform in its appearance, it varies in the size and rotundity of its constituent nubeculae, and in their closer or more distant arrangement. It is frequent in summer, and often forms very beautiful skies: at all times of the year it may be seen, in the intervals of showers, and before an increase of temperature, of which its prevalence is a pretty certain prognostic.*

* Extensive beds of cirrocumuli floating gently along in different altitudes must have attracted almost every body's notice; the beautiful appearance of these clouds, with a moonlight evening, has been aptly described by Bloomfield:

The distinct formation of the cirrus is not always a necessary precursor of the cirrocumulus; the latter frequently forms primarily. This may happen, perhaps, in consequence of a supervening current of air, warmer than the lower, and supersaturated with vapour, which coming in contact with the colder one below, is thrown into a state of aqueous gas, which, from peculiarities in the electric state of the air, may assume the cirrocumulative form. The supposition that cirrocumulus may be caused by an upper current, warmer than that below, assists us to account for its being usually followed by increased warmth. For many atmospheric changes take place first aloft and proceed downwards to the surface of our earth.

"Far yet above these wafted clouds are seen,
In a remoter sky, still more serene,
Others detached in ranges through the air,
Spotless as snow, and countless as they're fair;
Scattered immensely wide, from east to west,
The beauteous semblance of a flock at rest."

The Farmer's Boy—Winter.

SECTION VI.

Of the Cirrostratus. Pl. II. Fig. 2.

CIRROSTRATVS. NVBES EXTENVATA SVBCOCAVA VEL VNDVLATA. NVBECVLAE HVIVS MODI ADPOSITAE.

I OBSERVED, when treating of the cirrus, that that cloud frequently changed into some other. Its change is generally into either the cirrocumulus or cirrostratus: when it passes to the latter, it descends lower in the atmosphere, its fibres become denser and in general more regularly horizontal, and it usually appears subsiding, or altering its form. The figure of the cirrostratus, like that of the cirrus, is very various: sometimes it consists in dense longitudinal streaks; at others it looks like shoals of fish; sometimes the whole sky is so mottled with it as to give the idea of the back of the mackerel; this has been called the mackerelback sky; frequently it appears like the grains of polished wood, or is composed of fine fibres, disposed after the manner of the fibres of muscles, which often intersect each other.

I have seen the cirrostratus assume the reticular form, like the cirrus, from which it can then only be distinguished by its greater degree of density. This cloud is sometimes spread out into a plane horizontal sheet, more or less dense; this is the form in which the halo generally appears. All clouds are capable of becoming lighter or darker, according to their relative position with respect to the sun: the cirrostratus, however, is remarkable for exhibiting a great variety of beautiful colours, according to its variation in density, to other peculiarities in its structure, or to its relative position. These appearances are best seen in the morning and evening, when the sun is near to the horizon. They have been well described by the ancient poets,* who have likewise spoken

* VIRGIL, speaking of the prognostics of rain, alludes to several appearances which must be ascribed to the intervention of this cloud.

Sol quoque et exoriens et quum se condit in undas
Signa dabit, solem certissima signa sequuntur
Et quae mane refert et quae surgentibus astris,
Ille ubi nascentem maculis variaverit ortum
Conditus in nubem medioque refugerit orbe
Suspecti tibi sint imbres, namque urguet ab alto

of them as precursors of rain and tempestuous weather: and modern meteorologists have corroborated the speculative notions of the ancients, and have observed the prevalence of the cirrostratus to be usually followed by bad weather, as will be further discussed when I come to speak of prognostics of atmospheric changes.

Arboribusque satisque notus pecorique sinister,
Aut ubi sub lucem densa inter nubila sese
Diversi rumpent radii, aut ubi pallida surget
Tithoni croceum linquens Aurora cubile
Heu male tum mitis defendent pampinus uvas
Tam multa in tectis crepitans salit horrida grando.
Hoc etiam emenso quum jam decedat Olympo
Profuerit meminisse magis, nam saepe videmus
Ipsius in voltu varios errare colores
Caeruleus pluviam denunciat, igneus Euros
Sin maculae incipient rutilo inmiscerier igni
Omnia tum pariter vento nimbisque videbis
Fervere: non illa quisquam me nocte per altum
Ire neque a terra moneat convellere funem,
At si quum referetque diem conditque relatum
Lucidus orbis erit, frustra terrebere nimbis
Et claro sylvas cernes aquilone moveri.

Virg. Geor. lib. i. 460.

The *radii diversi se erumpentes* are probably the same as the ῥαβδοι, described by Aristotle, in his *Meteorologica.*

SECTION VII.

Of the Cumulostratus. Pl. III. Fig. 1.

CVMVLOSTRATVS. Def. NVBES DENSA IRREGVLARIS BASIN PLANAM VNDIQUE SVPERCRESCENS.

THE change of the cumulus into the cumulostratus is effected in the following manner: The cumulus, losing its hemispherical figure, increases irregularly upward grows more dense, and overhangs its base in uneven or rugged folds; a preexisting cirrus, cirrocumulus, or cirrostratus, or one perhaps immediately formed for the occasion, alights on its summit, and inosculates. Many of these cirrostrati are sometimes seen attached to the cumulostratus, and sometimes to intersect it. Cumulostrati frequently remain in this state for a long time, and constitute very picturesque skies. At other times the processes are more rapid. The cirri or cirrostrati are soon lost in the cumulostratus, which increases in density, and soon becomes the nimbus described in the next section. The distinct appearance of the supersident cirri, or cirrostrati, is not neces-

sary to the production of the cumulostratus; on the contrary, the cumulus as often passes to this cloud, and eventually to the nimbus, without the visible precedence of any such conjuncture and inosculation of different modifications. But it is probable that the same kind of processes are going on unseen, and that a similar change always takes place in the electricity of the cumulus, previous to its becoming the cumulostratus. The change being often visibly effected by the anastamosis of two strata of cloud, as above described, and the two strata having been found by experiment to be differently electrified, we are led to conclude that the process of nimbification, of which cumulostratus is one stage, consists in a neutralization of the electricities of two or more clouds; and that where cumulostratus or nimbus appears, unpreceded by the aforedescribed phenomena, the same kind of change has taken place in the aqueous aggregates, from causes which are invisible.*

The cumulostratus varies in appearance;

* See the experiments of Cavallo with the electrical kite, &c.—*Comp. Treat. Elect.* 2d Ed. p. 370.

sometimes it overhangs a perpendicular stem, and looks like a great mushroom; frequently a long range of cumulostrati appear together, which have the appearance of a chain of mountains with silvery tops.* Before thunderstorms it seems frequently reddish, which some people have imagined to arise from its being highly charged with the electric fluid. Of this, however, more in another place.

SECTION VIII.

Of the Nimbus. Pl. V. Fig. 1.

NIMBVS. Def. NVBES VEL NVBIVM CONGERIES PLVVIAM EFFVNDENS.

CLOUDS of any one of the aforementioned modifications, at the same degree of eleva-

* The simple cumulus sometimes has this appearance; and as the change to cumulostratus is gradual, it is often difficult to determine to which modification to ascribe it. A continuity of base to several mountainous superstructures, and an increasing density of colour which by degrees approximates to black, mark the progress of the change to cumulostratus.

tion, may increase so much as completely to obscure the sky: two or more different modifications may also do the same thing in different elevations, and the effect of this obscuration may be such as would induce an inattentive observer to expect the speedy fall of rain. It appears, however, from attentive observation, that no cloud effuses rain until it has previously undergone a change sufficiently remarkable to constitute it a distinct modification, to which the term nimbus has properly been applied.* This change seems to consist in the uniting of particles of water differently electrified, which, having a mutual attraction for each other, closely unite, forming visible drops of water, which therefore gravitate and descend in rain. The nature of this process will, perhaps, be better understood, if I advert to

* This application of the word nimbus corresponds very well with the sense in which it was taken by some of the old Roman writers, who considered it as a storm cloud, and distinguished from imber or a shower of rain actually falling. Thus Lucretius—

Copia nimborum, turba majore coacta,
Vrguens ex supero premit ac facit effluere imbris.

Lucr. de Rer. Nat. vi. 512.

what frequently happens in the rapid production of showers. The cumulus, sailing along in a lower region, appears retarded in its progress, increases upwards, and inosculates with a cirrus or cirrostratus above; then the whole changes into cumulostratus, and spreads horizontally, forming a dense sheet; a sort of crown of cirrose fibres extends upward from the superior part, while loose flocky cumuli, entering from below, seem to nourish the growing nimbus, which, increasing in density, at length descends in rain, the drops or streams of which appear, by inosculation in falling, to acquire magnitude in their progress to the earth. After the storm has spent itself, the mass is again disunited, and formed into the different modifications: the cirrus, cirrocumulus, and cirrostratus, may again be seen in the higher air, while the remaining part of the broken nimbus flies along in a lower station, in the form of that loose, flocky, and dark coloured cumulus, which the sailors call scud. In cases of more settled and continued rain, these processes go on slower, and therefore are less likely to be taken notice of. The best time for viewing the progress of nimbi-

fication is in stormy weather; cumuli may then be seen rising into mountains and becoming cumulostrati, while long strata of cirrostratus permeate their summits; and the whole phenomenon has the appearance of a range of mountains, transfixed by the mighty shafts of giants. After having existed some while in this form, they become large and irregular, and they get darker by intensity, till all seem concentrated in a dense black mass, with a cirrose crown extending from the top, and ragged cumuli entering from below; and eventually the whole resolves itself into rain.*

Having in this section given a sketch of the modifications, and of the principal circumstances which relate to their formation

* Previous to the coming up of a storm, a dead calm, which may have for some time existed, is followed by a gale. The approach of a storm, thus ushered in by wind, is admirably described by Virgil:

> Qualis ubi ad terras abrupto sidere nimbus
> It mare per medium; miseris heu praescia longe
> Horrescunt corda agricolis: dabit ille ruinas
> Arboribus stragemque satis, ruet omnia late
> Antevolent sonitumque ferunt ad littora venti.
>
> *Virg. Aeneid.* xii. 451.

and peculiarities, I proceed in the next to a further examination of the same subject.

SECTION IX.

By what has been said above, it appears that, according to Mr. Howard's theory, the origin of clouds is from the surface of the earth and waters. That the vapour upraised by the accession of the diurnal temperature, in the manner described, is condensed into a visible cloud, either by cold, or by the air, from other causes; losing its power of holding so much water in solution as before; or by the joint influence of these causes. That cumuli are the immediate result of this process; and that in the evening, when the heat is diminished, the air deposits its vapour again in the form of dew, which gravitates to the ground, becoming more dense as it approaches the earth, because the lower atmosphere is now the coolest; and finally lodges on the surface of the herbage, or of the ground, where it awaits the reascending sun to be again evaporated. Cumuli also are represented to be dispersed,

and their constituent particles to come to the ground in the same manner.* According to the same theory, it appears that the other modifications are also the consequence of vapour carried up into the atmosphere, while their peculiarities are more immediately effected by the agency of the electric fluid.

The conclusion of Mr. Howard's theory, as it is given in Rees's *Cyclopædia*, is so good, that I shall adopt it as a termination to this section.

"We shall conclude with a brief review of the modifications ascending from the STRATUS, formed by the condensation of vapour on its escape from the surface to the CUMULUS, collecting its water in the second stage of its ascent, both probably existing by virtue of a positive electricity. From these proceeding through the partially conducting CUMULOSTRATUS to the CIRROSTRATUS and CIRROCUMULUS; the latter positively charged, and considerably retentive of its

* Although the reason of their sinking may be the destruction of the vapour plane in the evening, yet some other cause must exist for the cumulus to disperse and fall in diffused mist, or dew: see the next Chapter.

charge; the former less perfectly insulated, and, perhaps, conducting horizontally: we arrive thus at the region where the CIRRUS, light and elevated, obeys every impulse or invitation of that fluid, which, while it finds a conductor, ever operates in silence; but which embodied and insulated in a denser collection of watery atoms, sooner or later bursts its barrier, leaps down in lightning, and glides through the NIMBUS from its elevated station to the earth."

SECTION X.

THOUGH the above theory appears very plausible, and is certainly in many respects accurately correct, yet there are other theories which are opposed to it in many particulars, and which seem likewise to have some pretensions to credit. I shall proceed next to mention some of these, and compare them with that of Mr. Howard. It is contended by some that the dew does not fall, but, on the contrary, rises: the earth, it is said, retains the heat of the day longer than the air immediately above it: that evapora-

tion being greater, according to the proportion of heat which the water bears to the air into which it evaporates, there becomes a considerable evaporation from the earth and waters in the evening, which is condensed again in the cold air. I readily allow that this may take place; but it does not appear to me to militate against what has been advanced in the preceding Section. Evaporation may still be going on from below, while there is a precipitation from above; and thus we may account for the stratus not always resting on the ground, but frequently beginning at a small distance from it, or increasing in density for some feet upwards, there being a sort of shallow vapour plane preserved so long as the heat continued to be slowly transmitted from the earth.

M. De Luc asserts that clouds are not the constant result of evaporation from the earth. He accounts for them by supposing that the air is decomposed by the sun's rays, so as to deposit aqueous particles, which become clouds. If this be admitted to take place, it does not argue against the ascent of vapour: and whether the watery parti-

cles arise immediately from the ground, or are deposited by the air, they may equally be supposed capable of becoming cloud, when operated upon by the nubific principle which is believed to be electrical: indeed, these two processes may co-operate to the production of clouds, so that, if this hypothesis be advanced against Mr. Howard's theory, it cannot be regarded as constituting a valid objection.*

* The following extract will, perhaps, furnish to the reader a more perfect idea of Mr. Howard's theory of the origin of clouds:

" On the remote and universal origin of clouds there can be but one opinion—that the water of which they consist has been carried into the atmosphere by evaporation. It is on the nature of this process, the state in which the vapour subsists for a time, and the means by which the water becomes again visible, that the greatest diversity of opinion has prevailed.

" The chemical philosopher, seduced by analogy, and accustomed more to the action of liquids on solids, naturally regards evaporation as a solution of water in the atmosphere, and the appearance of cloud as the first indication of its precipitation; which becoming afterwards (under favourable circumstances) more abundant, produces rain. The theory of Dr. Hutton goes a step further, assumes a certain rate of solution differing from that of the advance of temperature by which it is effected, and deduces a general explanation of clouds and rain

It is said again, that nimbi have been observed to take place without the pre-

from the precipitation which, according to his rule, should result from every mixture of different portions of saturated air. The fundamental principle of this theory has been disproved in an essay heretofore presented to the society,* and which was written under the opinion, at present generally adopted by chemists, that evaporation depends on a solvent power in the atmosphere, and follows the general rules of chemical solution.

" The author has since espoused a theory of evaporation which altogether excludes the abovementioned opinion (and consequently Dr. Hutton's also,) and considers himself in a considerable degree indebted to it for the origin of the explanation he is about to offer. It will be proper, therefore, to state the fundamental propositions of this theory, with such other parts as appear immediately necessary, referring for mathemetical demonstrations and detail of experiments to the work itself, which is entitled " Experimental Essays on the Constitution of mixed Gases; on the Force of Steam or Vapour from Water aud other Liquids in different Temperatures, both in a Torricellian Vacuum and in Air; on Evaporation; and on the Expansion of Elastic Fluids by Heat. By John Dalton."—See Memoirs of the Literary and Philosophical Society of Manchester, vol. v. part 2.—The propositions are as follow:

' 1. When two elastic fluids, denoted by *A* and *B*, are mixed together, there is no mutual repulsion amongst their particles; that is, the particles of *A* do not repel

* See Phil. Mag. vol. xiv. p. 55.

currence of other modifications; but I have seen it no where proved, that after their

those of *B*, as they do one another. Consequently, the pressure or whole weight upon any one particle arises solely from those of its own kind.

'2. The force of stream from all liquids is the same at equal distances above or below the several temperatures at which they boil in the open air; and that force is the same under any other pressure of another elastic fluid as it is *in vacuo*. Thus the force of aqueous vapour of 212° is equal to 30 inches of mercury; at 30° below, or 182°, it is of half that force; and at 40° above, or 252°, it is of double the force: so likewise the vapour from sulphuric ether which boils at 102°, then supporting 30 inches of mercury, at 30° below that temperature it has half the force, and at 40° above it, double the force: and so on in other liquids. Moreover, the force of aqueous vapour of 60° is nearly equal to half an inch of mercury when admitted into a Torricellian vacuum; and water of the same temperature, confined with perfectly dry air, increases the elasticity to just the same amount.

'3. The quantity of any liquid evaporated in the open air is directly as the force of stream from such liquid as its temperature, all other circumstances being the same.'

The following is part of the Essay on Evaporation:

"When a liquid is exposed to the air, it becomes gradually dissipated in it; the process by which this effect is produced we call *evaporation*.

"Many philosophers concur in the theory of chemical solution: atmospheric air, it is said, has an affinity

formation rain has gone on without a cirrose crown on the upper part of the nimbus.

for water; it is a menstruum in which water is soluble to a certain degree. It is allowed, notwithstanding, by all, that each liquid is convertible into an elastic vapour *in vacuo*, which can subsist independently in any temperature: but as the utmost forces of these vapours are inferior to the pressure of the atmosphere in ordinary temperatures, they are supposed to be incapable of existing in it in the same way as they do in a Torricellian vacuum: hence the notion of affinity is induced. According to this theory of evaporation, atmospheric air (and every other species of air for aught that appears) dissolves water, alcohol, ether, acids, and even metals. Water below 212° is chemically combined with the gases; above 212° it assumes a new form, and becomes a distinct elastic fluid, called *steam*: whether water first chemically combined with air, and then, heated above 212°, is detached from the air or remains with it, the advocates of the theory have not determined. This theory has always been considered as complex, and attended with difficulties: so much that M. Pictet and others have rejected it, and adopted that which admits of distinct elastic vapours in the atmosphere at all temperatures, uncombined with either of the principal constituent gases, as being much more simple and easy of explication than the other; though they do not remove the grand objection to it, arising from atmospheric pressure."

"*On the Evaporation of Water below* 212°.

"I have frequently tried the evaporation at all the

I have noticed the spontaneous formation of nimbi more than once. Of this I shall

temperatures below 212: it would be tedious to enter into detail of all the experiments, but I shall give the results at some remarkable points. In all the high temperatures I used the vessel abovementioned,* keeping a thermometer in it, by which I could secure a constant heat, or at least keep it oscillated within narrow limits.

"The evaporation from water of 180° was from 18 to 22 grains per minute, according to circumstances; or about one-half of that at 212°.

"At 164° it was about one-third of the quantity at the boiling temperature, or from 10 to 16 grains per minute.

"At 152° it was only one-fourth of that at boiling, or from 8 to 12 grains, according to circumstances.

"The temperature of 144° affords one-fifth of the effect at boiling; 138° gave one-sixth, &c.

"Having previously to these experiments determined the force of aqueous vapour at all the temperatures under 212°, I was naturally led to examine whether the quantity of water evaporated in a given time bore any proportion to the force of vapour of the same temperature, and was agreeably surprised to find that they exactly corresponded in every part of the thermometric scale; thus the forces of vapour at 212°, 180°, 164°, 152°, 144°, and 138°, are equal to 30, 15, 10, 7½, 6, and 5 inches of mercury respectively: and the grains of water evaporated per minute in those temperatures were 30, 15, 10,

* This refers to experiments on the evaporation of water at 212° for which see the Essay.

say more hereafter, when I shall attempt further to illustrate these subjects by a detail

$7\frac{1}{2}$, 6, and 5, also; or numbers proportional to these. Indeed it should be so from the established law of mechanics, that all effects are proportional to the causes producing them. The atmosphere, it should seem, obstructs the diffusion of vapour, which would otherwise be almost instantaneous, as *in vacuo*; but this obstruction is overcome in proportion to the force of the vapour. The obstruction, however, cannot arise from the weight of the atmosphere, as has till now been supposed; for then it would effectually prevent any vapour from arising under 212°: but it is caused by the *vis inertiæ* of the particles of air, and is similar to that which a stream of water meets with in descending amongst pebbles.

"The theory of evaporation being thus manifested from experiments in high temperatures, I found that if it was to be verified by experiments in low temperatures regard must be had to the force of vapour actually existing in the atmosphere at the time. For instance, if water of 59° were the subject, the force of vapour of that temperature is 1-60th of the force at 212°, and one might expect the quantity of evaporation 1-60th also: but if it should happen, as it sometimes does in summer, that an aqueous atmosphere to that amount does already exist, the evaporation, instead of being 1-60th of that from boiling water, would be nothing at all. On the other hand, if the aqueous atmosphere were less than that, suppose one half of it, corresponding to 39° of heat, then the effective evaporating force would be 1-120th of that from boiling water: in short, the evaporating force must be universally equal to that of the tem-

of some particular cases.—In the conclusion of this chapter, I may observe, that if, agreeable

perature of the water, diminished by that already existing in the atmosphere. In order to find the force of the aqueous atmosphere I usually take a tall cylindrical glass jar, dry on the outside, and fill it with cold spring water fresh from the well: if dew be immediately formed on the outside, I pour the water out, let it stand a while to increase in heat, dry the outside of the glass well with a linen cloth, and then pour the water in again: this operation is to be continued till dew ceases to be formed, and then the temperature of the water must be observed; and opposite to it in the table will be found the force of vapour in the atmosphere. This must be done in the open air, or at a window; because the air within is generally more humid, than that without. Spring water is generally about 50°, and will mostly answer the purpose the three hottest months in the year; in other seasons an artificial cold mixture is required. The accuracy of the result obtained this way I think scarcely needs to be insisted upon. Glass, and all other hard, smooth substances I have tried, when cooled to a degree below what the surrounding aqueous vapour can support, cause it to be condensed on their surfaces into water. The degree of cold is usually from 1 to 10 below the mean heat of the 24 hours; in summer I have often observed the point as high as 58° or 59°, corresponding to half an inch of mercury in force; and once or twice have seen it at 62°; in changeable and windy weather it is liable to considerable fluctuation: but this is not the place to enlarge upon it.

"For the purpose of observing the evaporation in

to the experiments of modern chemists, the conversion of fluids into elastic vapour is at-

atmospheric temperatures I got two light tin vessels, the one six inches in diameter and half an inch deep, the other eight inches diameter and three-fourths of an inch deep, and made to be suspended from a balance. When any experiment, designed as a test of the theory, was made, a quantity of water was put into one of these (generally the six-inch one, which I preferred,) the whole was weighed to a grain; then it was placed in an open window or other exposed situation for 10 or 15 minutes, and again weighed to ascertain the loss by evaporation; at the same time the temperature of the water was observed, the force of the aqueous atmosphere ascertained as above, and the strength of the current of air noticed. From a great variety of experiments made both in the winter and summer, and when the evaporating force was strong and weak, I have found the results entirely conformable with the above theory. The same quantity is evaporated with the same evaporating force thus determined, whatever be the temperature of the air, as near as can be judged; but with the same evaporating force, a strong wind will double the effect produced in a still atmosphere. Thus, if the aqueous atmosphere be correspondent to 40° of temperature and the air be 60°, the evaporation is the same as if the aqueous atmosphere were at 60° of temperature and the air 72°; and in a calm air the evaporation from a vessel of six inches in diameter in such circumstances would be about ·9 of a grain per minute, and about 1·8 grains per minute in a very strong wind; the different intermediate quantities being regulated solely by the force of the wind.

tended with a loss of heat; the vapour from water, by rendering the upper atmosphere

"Having quoted so much of this essay as may suffice to exhibit the principles on which we shall proceed, it may be useful, before we do this, to recapitulate the following circumstances respecting the atmosphere of aqueous gas, or (for brevity) the aqueous atmosphere.

"1st. It is supplied by the process of evaporation, which by this theory appears to be reduced to the immediate union of water with caloric into a binary compound, *aqueous gas.*

"2dly. The supply of vapour (by which term, for the purposes of meteorology, we may denote aqueous gas,) is regulated by the following circumstances:—1. Temperature of the evaporating water, being greater as this is higher, and *vice versâ.* 2. Quantity of surface exposed. Since it is from the surface only of the mass that the vapour in common cases can escape, the supply is in direct proportion thereto. 3. Quantity of vapour already subsisting in the atmosphere: the evaporation being less (with equal temperature and surface) in proportion as this is greater, and *vice versâ.*

"3dly. The vapour thus thrown into the atmosphere is diffusible therein by its own elasticity, which suffices for its ascent to any height in a perfect calm. Yet, as in this case the *inertia* of the particles of air considerably resists its diffusion, so in the opposite one of a brisk current, the vapour, by the same rule, must in some measure be drawn along with the mass into which it enters.

"4thly. The quantity of vapour which, under equal pressure, can subsist in a given mass of air, will be

into which it ascends cooler than it was before, also renders it less capable, agreeable

greater as the common temperature is higher, and *vice versa*.

"Aqueous vàpour is the only gas contained in the atmosphere which is subject to very sensible variations in quantity. These variations arise from its attraction for caloric being inferior to that of all the others. Hence when a cold body, such as the glass of water in the experiment above quoted, is presented to the atmosphere, the other gases, composing the latter, will only be cooled by it (and that at all known temperatures;) but the vapour, after being more or less cooled, will begin to be decomposed, its caloric entering the body while the water is left on the surface.

"The formation of cloud is in all cases the *remote* consequence of a decomposition thus effected, except that the caloric escapes, not into a solid or liquid, but into the surrounding gases.

"Dew is the *immediate* result of this decomposition. The particles of water constituting it are, singly, invisible, on account of their extreme minuteness. The approach of dew is, nevertheless, discoverable by a dark hazy appearance, verging from purple to faint red, extending from the horizon to a small distance upwards, and most conspicuous over valleys and large pieces of water.

"The theory of dew seems to be simply this:—during the heat of the day a great quantity of vapour is thrown into the atmosphere from the surface of the earth and waters. When the evening returns, if the vapour has not been carried off in part by currents, it will often

to Mr. Howard's theory, of containing so much aqueous gas in solution, which thus contributes to effect its own condensation into clouds: by which process there is produced again an increase of heat; and by this means the degree of temperature is in some measure restored.

happen that more remains diffused in the general atmosphere than the temperature of the night will permit to subsist under the full pressure of the aqueous atmosphere. A decomposition of the latter then commences, and is continued until the general temperature and aqueous pressure arrive at an equilibrium, or until the returning sun puts an end to the process. The caloric of the decomposed vapour goes to maintain the general temperature; while the water is separated in drops, which, minute as they are, arrive successively at the earth in the space of a few hours. That the ordinary production of dew is by a real *descent* of water from the atmosphere, and not by decomposition of vapour on surfaces previously cooled (as in the experiment already mentioned) any one may readily be convinced by observing in what abundance it is collected by substances which are wholly unfit to carry off the requisite quantity of caloric for the latter effect."—*Phil. Mag*. Sep. 1803.

CHAPTER II.

FURTHER OBSERVATIONS ABOUT THE PECULIARITIES OF THE CLOUDS.

In the foregoing chapter I have given a hasty and imperfect sketch of Mr. Howard's theory of the origin, suspension, and destruction of clouds. I shall next proceed to examine further the various appearances which the different modifications present in the progress of their formation, changes, and destruction; the influence which they appear to have on each other, and the connexion observable between their peculiarities and other atmospheric phaenomena. The reader will see how far these phaenomena are reconcileable with what has been already said in the above chapter. In investigating the causes of these changes, I have selected such few cases as appeared necessary to illustrate them, and for further particulars I refer to the Appendix at the end of the volume, and to my journal in the Philosophical Maga-

zine. In this journal, it may be said, I have been too minute in the detail of appearances. But where effects are intricate and complex, an accurate detail of them appears the only thing that can lead to a knowledge of their particular causes.

SECTION I.

Of the Varieties of the Cirrus.

I HAVE already said that the cirrus was by no means uniform in its appearance; but, on the contrary, that it exhibited a very great variety of figure, both while it remained a determinate cirrus, and when passing to the other modifications. That these varieties are the effect of a variation in the cause of the cloud, cannot be doubted; many of them are attendant upon particular kinds of weather; and an accurate examination of them, compared with other coexisting phaenomena, seems likely to throw additional light on the nature of the peculiar office which the cirrus performs; namely, that of conducting the electric fluid.

When the weather is dry, the cirrus has

more of a fibrous texture then when it is damp; and whatever may be its figure, whether comoid, linear, or filiform, its extremities are always fine evanescent points. This is a fact very conformable to our present idea of its nature. For when surrounded by dry air, which is an electric, there is not a free passage for communication; and the cirrus necessarily assumes that form which is best calculated for conducting, the evanescent terminations being probably points for the transmission of the fluid, and they are directed towards that part of the sky with which the electric communication is to take place.

On the 30th of August, 1811, the air being very dry, according to the hygrometer, the cirri were spread about in a lofty region; they were of a fibrous texture, one end terminating in transmitting points, the other frequently more massy; they passed on gently with the wind, in succession; by the evening none were to be seen. Cumuli also, formed during the day in a lower atmosphere, moved along in the lower current, and likewise disappeared at night. The dryness of the air might be the reason why

these two kinds of clouds did not affect each other, so as to produce cumulostratus and nimbus, by their union.

In wet weather, when the air is damp, the cirrus, which is seen in the intervals of the rain, is ill defined, and often of a sort of plumose figure; and it has less of the fibrous structure: this may be attributed to its being surrounded with moister air, which being a conductor, though an imperfect one, there is not the same necessity for the cirrus to be drawn out into fine transmitting points; as the fluid can fly off more generally from all parts of it. Cirri of this kind are generally of short duration, and have a great tendency to change into the other modifications; there is often a haziness in the atmosphere when they appear, and they are frequently soon followed by rain. They seldom appear in fair dry weather; and if cirri, which have been previously fibrous, put on the plumose and indefinite character, a change to wet weather may be expected. All these are circumstances which corroborate the opinion, that the humidity of the circumjacent air is the cause of this kind of feature of the cir-

rus, and agree very well with the nature of the office already assigned to it.

I have almost always found the fibrous cirri to be accompanied by dry air. But there are rare exceptions to this rule. The upper air may, however, be tolerably dry, while the under air is moister, which may account for the occasional appearance of cirri of fibrous texture above, at a time when the hygrometer indicates a humid atmosphere below.

The plumose cirrus often appears when the sky is deep blue, and the cirrus of fibrous structure sometimes appears when it is pale coloured. But the intensity of the blue of the sky does not seem to depend on the dryness of the air; nor the paleness, on its moisture. In the intervals of showers the intensity of the blue is often the greatest.* While I am now writing, I observe out of my window abundance of fibrous cirri in a sky rather pale than otherwise. During the abundance of cirri I have sometimes per-

* Sir Isaac Newton somewhere observes that the deepest blue sky happens just at the change from a dry to a moist atmosphere.

ceived the sky particularly pale; which, on minute examination, have been found to be caused by innumerable fine fibres of cirrus laying very close together.

There is a variety of the cirrus, called in Lincolnshire the Sea Tree, which has somewhat of the plumose structure, and generally precedes rain. Its figure gives a faint resemblance to that of a tree, whence it derives its name, one end being a compact kind of trunk, from which fibres diverge and ramify into confused or plumose branches.*

The obliquely descending bands of cirrus, before mentioned, which occur chiefly in fair warm weather with light gales of wind, are not always detached. I have seen them proceeding from other clouds, and sometimes connecting two distant masses of cloud, which in this case have always been undergoing a change of appearance, reconcileable with the idea of a change in their electric state.

The detached comoid cirri, called Mares' Tails, are seldom very much elevated, par-

* By plumose, is meant a figure which gives the idea of the folded ends of a plume of feathers. The sea tree sometimes looks like many of these plumes diverging from one stem.

ticularly those which ramify vertically. Their presence is well known to be an indication of wind; and when their transmitting terminations have a decided direction, the subsequent wind has been often found to blow from the quarter to which they have previously pointed. This circumstance seems difficult of explanation. For if we suppose a current of air, differently electrified, to precede the more violent and sensible wind that is to follow, with which the cirrus communicates its electricity by means of these pointing fibres; how comes the cirrus itself, though apparently stationary, to be actually moving on slowly in an opposite direction? which I have observed to be the case: and, indeed, cirri in general move along with their tails either foremost or aslant. If these cirri, then, be moved along by the current of air, it cannot be imagined that there can be a current of differently electrified air meeting them, which should draw out their tails into transmitting points. For if two currents meet, which ever was strongest would counteract the other, and would move the cirrus at the rate of the difference of the two velocities. It is dif-

ficult, too, to suppose that there can be a tide of electricity moving against the wind; but it is possible that the cirrus may not be carried forward by the mechanical impulse of wind. The same electric attraction, which may draw out its cirriform tail for the purpose of equalization, may be supposed, furthermore, to move slowly the whole mass in the same direction. I never could quite satisfy myself on this point. Perhaps the electric attraction, which draws out the cirrus into transmitting points, exercises its power quite independent of the wind then blowing; for these cirri sometimes move in a direction very different from the direction of their tails: besides, the cirrus has been observed to continue moving on, in the same direction, while the tails have veered round toward another quarter.*

There is sometimes a kind of motion observable in the cirrus, which I have never

* Whether by the fleeces of wool, which Aratus, Virgil, and Lucretius speak of, as being carried across the welkin in rainy weather, were intended these comoid cirri, cirrostrati, cirrocumuli, or large flocky scud, is uncertain. They intended, however, to describe the peculiar clouds which accompany variable weather.

noticed in any other cloud, which it is somewhat difficult to describe, and which, whenever I have seen it, has happened in a cirrus of a particular kind; namely, in one which has a sort of plumose extremity, with a long fibrous body, and a fine transmitting pointed tail.* The plumose head, which under these circumstances is clearer and rather more fibrous than usual, together with the body, seem all in motion, as if every particle was alive. This motion may be compared to that of a piece of cheese full of mites, which seems agitated in every point, without ever materially changing its place. This was remarkably conspicuous in some cirri, which I saw from Farningham, in Kent, about 6 o'clock in the evening of the 16th of July, 1811. They pointed nearly to the East. The weather which preceded them was variable, with some showers, and they were succeeded by several days of fair dry weather with various clouds, at the end of which time happened a hard thunderstorm about three in the morning. Can this motion possibly be the effect of an effort on the part of

* Plate I. Fig. 2.

the electrified particles of the cloud, to equalize their own electricity with that of the air? or may there be some disturbance in the electricity within the cloud, from other causes? Sometimes portions of the cloud seem lightly agitated, as if by partial but gentle draughts of wind. Can the motion alluded to be caused by the evolution of any air generated in the cloud?

When the cirrus ceases to conduct, it changes its form, and becomes some other cloud, as has been said: thus, sometimes a sky full of cirrous streaks, after a while becomes overspread with a milky whiteness. This is a sort of change to cirrostratus, which often ends in rain.* The cirri however frequently change to the cirrocumulus; and in the progress of the change the cirrous fibres seem to shoot out laterally into trans-

* The Abbé Bertholin probably alludes to the cirrus, as well as to scudlike cumulus, and other transitory features of the modifications, which appear in the intervals of showers, when he speaks of the "Lambeaux et fragments de nuages qui sont comme disseminés dans les differentes regions de l'air, les uns sont plus hauts (cirri, &c.) les autres plus bas (scud, &c.) et flottent au gre des vents de divers côtés." He speaks of them as vehicles of the electric fluid, and as useful in conveying away the

verse and intersecting streaks; they first change to cirrocumulus at their points of intersection, which thicken, approach to the orbicular form, and seem like centres from which fibres eradiate; thus a sort of filiform cirrocumulus is effected, which either goes on changing to a more perfect feature of that cloud, changes again to cirrus or to cirrostratus, or evaporates. It often happens that, as the cloud is gently moving on, the spectator has not an opportunity of watching it throughout all its metamorphoses.

SECTION II.

Of the Varieties of the Cirrocumulus.

THE permanent features of any cloud should be distinguished from those which are only transitory, or which the cloud exhibits in the progress of its change from

matter of lightning, which would otherwise be oftener embodied in large clouds, and strike the earth with terrible violence. Thus he seems to have had some faint notion of an office performed by clouds, which more recent discoveries have ascribed to the cirrus. See *Berthol. De l'Elec. Met. t. II. p.* 113.

one modification to another. I have before noticed, that in the change from the cirrus to the cirrocumulus, a number of appearances present themselves, which cannot be referred to either. They generally, however, end in a determinable modification, which I call its permanent form; and in which it generally remains for some time, and then evaporates, or changes again. The permanent features of the cirrocumulus vary at different times, and the varieties are connected with particular states of the atmosphere. In fine warm weather in summer, particularly towards evening, the nubeculae which compose this cloud are often large, well defined, and separate from each other: the whole sky is sometimes replete with them. This feature is often the forerunner of fine and wholesome, after a long continuation of wet and variable, weather: it is strikingly contrasted to that variety of cirrocumulus which is composed of very diminutive nubeculae; by which the sky seems sometimes peppered, if I may so express myself, with innumerable little round white specks, which are sometimes of so

light a texture as to be almost transparent. There is a sort of cloud of this latter sort, which, though its nubeculae preserve something of the round shape of the cirrocumulus, has the light and flimsy appearance, and almost transparency of cirrostratus of one kind, and it becomes very difficult to know what name to give it. Refer to the tenth Section of this Chapter.

In stormy weather, previous to thunder, a cirrocumulus often appears, whose component nubeculae are very dense and compact round bodies in very close arrangement. The prevalence of this feature, particularly when accompanied by cumulostratus, is a sure indication of an approaching storm.*

I have often had occasion to mention the cirrocumulus, as being very generally a foreboder of warmth. In Germany these clouds

* If the cirrocumulus, as Mr. Howard supposes, is a cloud positively charged and very retentive of it, the intensity and decided character of this feature indicates the very high state of its charge; this notion agrees very well with the circumstance of its accompanying thunderstorms. Are not the densest cumulostrati formed from its conjunction with the cumulus?

are called little sheep: and Professor Heyne has a note on them in his edition of Virgil.* And our poet Bloomfield has likewise compared them to a flock at rest, in a passage already cited. In certain weather cirrocumulus rapidly forms in different places in the sky, and soon subsides again, as is mentioned in another place.

SECTION III.

Of the Varieties of the Cirrostratus.

IT would be impossible to convey to the reader a complete detail of all the varieties of any cloud; for, as in every other natural production, no two appear exactly similar in all particulars of shape, size, situation, &c. But as the clouds, countless and innumerable as their shapes and sizes are, have a tendency, under certain circumstances at present not precisely known, to break out into some of the seven distinct modifications; so each modification has certain particular varie-

* Heyne's Virgil, 4 vols. 8vo. Lips. 1803. d Georg. i. 97, p. 314 of vol. i.

ties into which it forms itself on different occasions, and the meteorological speculator may be assisted, by having some of the principal of these pointed out to him.

The varieties of the cirrostratus are numerous; but throughout all of them this cloud preserves its distinguishing characteristics; namely, shallowness, and extent in proportion to the quantity of its substance; generally a horizontal position, and a tendency to alter its form and to subside. It is often lower down than a cirrus in the same sky, and a change from that cloud to cirrostratus is usually attended with a diminution of its altitude, a greater degree of density in its fibres, and in a more regularly horizontal position. The plane sheets of cirrostratus are the most simple of its forms: when these are not extensive, and are seen in the distance, they often look like a dense streak drawn along near to the horizon; but distinguishable from streaks of cirrus. There are some peculiar appearances of this kind, which, swelling somewhat in the middle, and seen below a more thin and extensive sheet of cloud, give the idea of the back of a great dolphin rising out of the

ocean. It is in the thin and extensive sheets of this cloud, covering the welkin before its condensation into water, that the halo appears.* It is this cloud which, under some unknown circumstances of atmospheric change, first in a diffused form obscures the sky, giving the sun, moon, or stars that dim light, and those peculiar refractions, spoken of in another place, and which often eventually becomes nimbiform, and ends in gentle and continued rain. The sun often sets apparently shrouded in a dense feature of this modification, and this is a sure indication of a wet morning. But let us turn to more elegant varieties of cirrostratus, which sometimes appear in longish irregular spots or in bars in close horizontal position.† Features of this kind are frequently of short duration, and move along very slowly in a high atmosphere, and appear subsiding by degrees; while perhaps other beds of it are forming in other places: a feature much like this appears in the intervals of showers.‡ There

* See Chapter III. † Pl. II. Fig. 2.

‡ What is called the mackerelback sky often consists of this feature spread over a large portion of the firmament: but a sort of cirrocumulus, in like manner spread aloft, likewise receives this whimsical appellation.

also appears in variable weather, and before storms, a feature of cirrostratus, like the cyma of architecture.* I have seen cirrostratus which did not lie, as it usually does, in a horizontal plane. A feature occurred on the 5th of March, 1810, in the north east, which was a long, tapering, inclined, and curved column of dark lakecoloured specks; above it were cirri scattered about like loose hay. But to describe the cirrostratus in all its varieties of mottles, specks, streaks, and lines, would swell too much this chapter, and the meteorologist must observe them for himself.

SECTION IV.

Of the Varieties of the Cumulus.

CUMULI vary in size and in the regularity of their forms; they have all the tendency to assume an irregular hemispherical figure: those which attend fair settled weather, which form soon after sunrise, become large, and inosculate into extensive masses in the middle

* Pl. III. Fig. 2.

of the day, and subside in the evening, are of the most regular shape. When they increase rapidly, and become more irregular, with fleecy bases, they will soon be cumulostrati, and are to be considered as indicating variable or wet weather: in this case they are lower down in the air, and of denser appearance. In the intervals of, and before showers, I have seen them very large, and yet moving along in the wind, like immense hemispheres of cloud, dense in the middle, with silvery summits, and constantly tending to become cumulostratus, and to reproduce the showers; which, when they last long, are nourished by dark flocky cumuli, entering into the raining nimbus from below. See Pl. V. Fig. 2.

Some of these little cumuli are not so fleecy as the rest; they are more compact in form, and, flying along rapidly between the showers, are considered as a foreboding of their return, and are called by the vulgar water waggons. The cumuli before keen March showers of snow, with North and East winds, have that look of transparency, and that definite though rugged edge, described in another place as happening also to cumulostratus.

Cumuli have sometimes appeared as it were tuberculated, and, though of their usual hemispherical sort of form, to be composed of numerous eminences, or lobes of cloud. I have not observed what peculiarities of weather these cumuli accompany.

It is curious to watch the formation of cumuli in a morning, and trace them, when it is possible, from the minute specks of cloud which, here and there, seem to form out of the atmosphere, to those large masses which move majestically along in the wind, and convey water from place to place for the irrigation of the earth. In fair weather, soon after sunrise, a small cloud appears; this increases, others form near it, and they fall into one another as if attracted: a large mass is at length upraised, and then all the smaller ones which form in its neighbourhood are soon lost, while the large one is augmented; and the spectator, though he seldom sees it in actual congression, feels no doubt that the disappearance of the smaller, and augmentation of the larger cloud, is owing to the larger mass having attracted the smaller into itself. It becomes a question however, why the small clouds are lost

to appearance before they are quite drawn into the larger one? Possibly when the small cloud is very near, or most of its vapours drawn away, the rest rush with velocity into the larger; as a magnet, when it has approached a larger within a certain distance, is forcibly and suddenly attracted to the latter. When these ephemeral mountains of electrified vapour have increased much, as they do towards the middle of the day; large ones often inosculate, and form dense and extensive irregular masses. Something else besides this, however, seems necessary to cause that density and continuity of a base, common to several superstructures which constitute cumulostratus.

On the dispersion of a stratus in the morning, we often see cumuli forming at its upper part; probably the same particles of vapour, on the return of the vapour plane, take the form of the cloud of day, and subside in fog again in the evening. See Plate II. Figs. 3, 4.

SECTION V.

Of the Varieties of the Stratus.

THOUGH most meteorological philosophers now concur in the general idea that dews and fogs are the result of vapour precipitated by the nocturnal decrease of temperature; yet the particular circumstances under which dew is formed in greater or less quantities, the time of night, and the kind of weather when it is most precipitated, and other facts relating to it, having been variously observed by different persons, have occasioned different views to be taken of their various causes. In this section, however, I shall confine myself to a few cursory observations on the varieties of appearance which the stratus presents.

Every body must have noticed the difference between the wet fogs (probably cirrostrati) which happen at all times of day, but often in a morning,* and the white

* In Cornwall they amount to fine rain almost; they call them the pride of the morning. Fine days frequently follow them.

mists which wet nothing, but only leave dew in drops on the herbage, which veil the meadows and valleys through a summer night; and ascend in the morning. As the temperature decreases in autumn, the stratus becomes thicker; the rays of the sun seem hardly able to overcome it, and it sometimes lasts throughout whole days; thus it gave rise in the minds of the antients, whose organization led them to express physical facts metaphorically, to the fable of Phoebus and Python.*

In the neighbourhood of great cities these fogs, impregnated with numerous effluvia and smoke, have a yellow appearance which is explainable; but even in country places the yellow fogs of November extend over large tracts of land.

Dense fogs also happen sometimes, and

* Thus Phoebus, or the sun, is solicited by Cupid, or love, the vernal influence, to court Daphne, and effect the fruits of love in summer's productions. He boasts to the little god of his recent victory over Python, or the fog spreading his pestiferous body over the meadows.

"Qui modo pestifero tot jugera ventre prementem
Stravimus innumeris tumidum Pythona sagittis."

Ovid Met. II. 10.

appear suddenly, in different places; while at other times fogs continue for weeks together; such as that very thick and long fog, though one that did not extend very high up, which in December, 1813, ushered in the long frost, which continued through January and February of the present year. This fog seems by its topological history to have travelled from the West, Eastward and Northward over our island. See some curious remarks about fogs, and particularly the extraordinary fog in France of 1783, in Bertholin, De l'Electricité des Meteors, Tom. II. Chap. 4, where the observations of different persons on this phaenomenon are duly noticed.

SECTION VI.

Of Cumulostratus.

WHETHER this cloud is formed with visible conjuction of different modifications, whether cumuli spontaneously assume its form, or whether it appears of itself previously, we must regard it as a stage towards nimbus. The very dense and black

appearance of this cloud coming up with the wind, and just ripening into a storm, must be familiar to every body. Where the rain has actually begun to fall, the blackness is changed for a more obscure and grey colour. This may be only the effect of the interposed water of the falling rain; but if not, and if the nimbus is effected by an intense union of the watery particles, as I at present believe, the intense blackness of the previous cumulostratus must depend on some other principle. The mountains of this cloud, and its different appearances are mentioned in another place.

SECTION VII.

Of Nimbi which result from the visible Coalescence of distinct Clouds.

AN artificial division may be made of nimbi into three kinds. Firstly; those which result from the visible coalescence of distinct clouds. Secondly; those which follow the interfusion of moisture between distinct clouds: and, thirdly; those which appear

to form spontaneously in the air, without the precurrence of either of the above phaenomena. All these may, I think, be explained on the principle of the union of the differently electrified particles of which the clouds are composed.

If a cirrus, after it has ceased to conduct electricity, should receive from either mass of air, between which it may have been conducting, an electric charge, agreeably to the present theory it would lose its cirriform figure, and take on some other, perhaps a cirrocumulus, and by degress would sink down towards the earth. Under such circumstances, it may come into actual contact with a cumulus rising from below by the upward propagation of diurnal temperature. Such a phaenomenon I have several times witnessed; and the result has been, the sudden commixture of both clouds into a denser mass, or nimbus, which has resolved itself into a gentle shower, and all has disappeared; the union of the two clouds thus apparently effecting the destruction of both.

Such showers, by visible inosculation, are of short duration: the process is soon finished; because the nimbus, thus formed, is

circumscribed by dry air, and has no source of supply: and clearness returns, because the superfluous aqueous particles, or such as cannot be retaken into composition by the air, have come to the ground in rain. When the circumjacent atmosphere had been moist, the process has been different, as described in the next section.

SECTION VIII.

Of Nimbi apparently caused by the interfusion of Moisture between distinct Clouds.

A CUMULUS arising in the lower atmosphere may be electrified differently from a cirrus, or any other cloud occupying a higher region; and these may both subside; the upper one, perhaps, by evaporation; and the lower by the usual vespertine descent, without uniting and forming the compound modifications. This appears to be frequently the case in very dry weather, when cirri may be observed in the higher air, changing their forms, passing to cirrocumulus and cirrostratus, and eventually subsiding, while

cumuli sail leisurely along below. And these appearances continue, for many days together, without producing cumulostratus; which, nevertheless, occasionally happens, from the cumulus rising up and meeting with some other cloud descending. This will sometimes produce a nimbus, as I described above. At other times, however, the cumulostratus thus formed proceeds no further, and even reassumes the character of simple cumulus, and subsides in the wonted way. These are circumstances which I have observed to attend a dry state of the air, by the hygrometer, etc.

Previous to rain, very different appearances frequently present themselves. The cumulus in the lower atmosphere changes its appearance, becomes denser, irregular in shape, and rocklike in its superstructure, with fleecy protuberances about its base; and, by degrees, is a complete cumulostratus. While this process is going on, cirri, cirrostrati, or cirrocumuli, which have previously appeared above, are lost, to all appearance, as if they had suddenly evaporated. The air will now be found damper, and there is frequently a visible mistiness above;

and the explanation which I have to offer for this phaenomenon is, that the humidity of the air between the clouds affords a means of communication between their different electricities; and that the cumulus, being the largest body, draws down the cirrus above, and is aggrandized, its previous electric state destroyed, and its structure altered by the change. The surrounding air being damp, the process goes on, affecting clouds more distant, and the result is nimbus and rain.

A free passage for the electric fluid being afforded by the humidity of the air, it may readily be imagined, that the cumulus below, and the cirrus above, differently electrified, would mutually attract each other; and that the cumulus, being the larger body, would draw down the particles of the cirrus, while it appears to be drawn upward in a proportionate degree, and rises into mountains. The sudden loss of the cirriform cloud above, instead of a visible descent, is not at all surprising; for its electric state being destroyed, and its particles being more powerfully attracted by the greater aggregate, they cease to be held together in a body. This sug-

gests another reason for thinking that it is not the simple attraction of aggregation alone which keeps the particles of clouds together in a mass.

When the cirrus above has been very large, I have observed the process to vary, in a manner quite conformable to my notions of the principles of action of the two clouds on each other. A sort of haziness having appeared between the two clouds, the cirrus loses its cirriform and fibrous figure, increases in density, and swells downward, to meet the cumulus rising from below and also changing its structure, till they have both united and formed a nimbus. The two clouds in this case being more nearly of a size when the communication of their electricities took place, neither of them drew the other into itself, while both, losing their electric state, went on to become separate nimbi, and united merely upon the principle of attraction by which a nimbus is held compact.

SECTION IX.

Of what has been called Spontaneous Nimbification.

By what has been said above, it appears that the cause of such a union between two differently electrified strata of cloud, is the humidity of the interjacent atmosphere: and this humidity, it seems, may take place either in consequence of the dispersion of some cloud from a cessation of the electric actions which kept it together in a mass, or by a more general deposition of haze from the oversaturated air. Either of these causes, by affording a communication of electricity between the differently electrified clouds, might cause their union, and the production of nimbus. I think this will explain the cause of the nimbus unpreceded by other clouds. For if the air, from unknown causes, can so deposit watery particles, which may be diffused through a large mass of air, if the said large tract of air, before dry, and consequently an electric, should have a plus and minus state, the watery particles diffused

in it would also receive such a division of electricity: but these electricities having now, by the general humidity, a communication almost as soon as formed, they might unite, so as to form rain. This is a process which would be comparatively slow and progressive: and thus we may account for what has been called, by some, the spontaneous formation of nimbi;* and, by others the gradual condensation of the air into rain,† which lasts whole days, and affords an example of the more slow and gentle operation of the same causes, which, when effected rapidly by the sudden union of clouds, produce the more temporary and violent phaenomena of showers and thunderstorms.

* M. I. A. De Luc mentions having observed this spontaneous nimbification, unpreceded by cirri, when he was at the top of high mountains. See some curious observations in his "Idees sur la Meteorologie," 2 vol. 8vo. London, 1786.

† In nimbum cogitur aër.

SECTION X.

Of certain Effects of the different Modifications on each other, by Approximation, or with Coalescence.

IT has been already stated, that the effect of the coalescence of two different modifications, as, for example, of cumulus with cirrus, has been the production of the cumulostratus, and finally nimbus; and also that nimbus has appeared to result from the vicinity of two different modifications, particularly when the interfused air has been damp. I proceed now to speak of more transitory effects produced on clouds by the approximation of others of a different modification. The most remarkable of these is the conversion of cirrus or cirrostratus into cirrocumulus, on the approach of cumulus, or cumulostratus. On the 12th June, 1811, the weather being showery, with clear intervals, while looking out of window at Plaistow, in company with Mr. Howard, I observed a cirrus scattered about in the East. Cumuli were at the same time flying along

in a lower current of air: presently, a large cumulus passed apparently under the aforesaid cirrus, which now seemed affected by the approach of the cumulus, and rapidly took on the form of a sort of stellated cirrocumulus: the cumulus, at the same time, increased in density, and approached more to the nature of cumulostratus. I have several times since seen this phaenomenon effected in the same manner. On the 16th June, 1811, a large mass of cumulostratus passing under long streaks of cirrostratus, the latter gradually, as the former approached, changed into cirrocumulus. For particulars relative to the kind of weather, state of meteorological instruments, &c. see Journal for the above two days in Phil. Mag. Analogy leads us to refer these phaenomena to the operation of the different electricities of the two clouds on each other. The effect of large masses of cumulus on smaller ones in their vicinity has been otherwise noticed. The approximation of clouds toward each other is always attended with some alteration of their appearance. And clouds are always operating on one another and altering each others' forms.

SECTION XI.

Of Thunderstorms.

THE paper of M. B. P. Van Mons, reprinted in Nicholson's Phil. Jour. Sept. 1809, induced me to observe accurately the two different kinds of lightning therein mentioned. I will not venture to speculate on their causes, referring for them to his paper, but shall proceed to state the difference, One kind is a vivid flash, shortly afterwards followed by a loud clap of thunder, resembling the sound of the discharge of a mortar or cannon: This is found to be the mischievous kind, and is attributed to the discharge of the fluid analogous to the flying off of the electric spark. The other kind, ascribed by M. Van Mons to the combustion of the gases of water, is not so vivid, but has more latitude of light and is followed by rolling thunder.* These two sorts often alternate in the same storm. But it is often the case in other storms that

*. Two kinds of lightning are mentioned by several ancient writers. Consult Seneca, Nat. Quaes. lib. ii. cc. 16. 20.

none but the rolling thunder is distinguished. The vespertine fulgurations, called summer lightning, are not followed by any thunder at all.

By a collation of journals, it appears that the occurrence of thunderstorms is often nearly simultaneous in very distant parts of the country, which indicates a disposition to their formation taking place in large tracts of atmosphere at once. But at other times they are very local and detached. For more particulars relative to the electric phaenomena of thunderstorms and nimbi in general, refer to the chapter on Electricity.

SECTION XII.

Of Masses of Cloud not to be referred to any of the Modifications.

Masses of cloud frequently appear, not referable for a time to any of the modifications: but even these, if they last long enough, generally break out into some modification ultimately: when they do not, they must be described in journals as well as they can;

but I have seldom seen any, which, if watched long enough, did not show sufficiently the character of some one of the modifications, to be registered under its name.

As I have before observed, it is not always an easy matter to an unexperienced meteorologist to determine to which modification every cloud he sees is to be referred. There are intermediate varieties of cirrus, cirrostratus, and cirrocumulus, which approach so much to the nature of each other that the assignation of a name becomes very difficult. A tendency to the orbicular arrangement is the distinguishing character of cirrocumulus; but sometimes features appear which have somewhat of this kind of arrangement. but are yet so light in their texture as to appear almost to be of the modification of cirrostratus. In my journals I have called these the cirrocumulative features of cirrostratus. There are many varieties of these indeterminable features: a flimsy cloud of this kind is often seen in the clearer intervals of rainy weather, which gives the idea of the flowers of the cauliflower. The innumerable little round spots of cloud which sometimes cover a great extent of sky at an

elevated station are sometimes of this flimsy and almost transparent structure, while at other times they are denser, and therefore more decidedly cirrocumuli. In some kinds of weather, often with easterly wind and during cold unwholesome air, a cloud is seen covering great part of the sky, which has the thin and transparent texture of cirrostratus; but the component nubeculae have the large and rounded form of cirrocumulus; it seems to differ from the latter cloud in being shallow and flimsy, and from the former in having a rounded circumscription.

Among the sportive and amusing features which are exhibited under other circumstances of atmospheric peculiarities, we have sometimes long tapering columns, horizontal or inclined, of a cloud composed sometimes of little cirrocumulous nubeculae, and sometimes of those of a sort of cirrostratus like little freckles; or like bundles of small streaks, arranged in rows. Mostly these little bunches of cloud are in a plane; but I have thought, though it might be an optical deception, that they have been sometimes in a roundish column, giving a faint resemblance to the tail of an armadillo.

I once saw a column of this sort inclined, curved, apparently pendant from a sort of cirrus, and coloured purple and lake by the setting sun one afternoon in keen March weather.* The cloud which gives what is called the makerelback sky is composed of the long waving cirrostrative nubeculae, but these sometimes acquire the apparent substance and solid look of cirrocumulus.

In the large and long beds of nubeculae, which frequently float gently over in summer, there is often cirrostratus and cirrocumulus in the same bed: these change from one to another by degrees; and there are intermediate and also confused or plain features in the same flotilla of travelling waters.

Thus we see that though there be intermediate and mixed features, they have a constant resemblance more or less to one or other of them, and a tendency to assume sooner or later some regular form; a circumstance which shows the distinct nature of the modifications, and persuades us that the names have not been imposed at hap-

* Described under the account of the cirrostratus.

hazard or on artificial or imaginary distinctions; but that they represent distinct and obvious genera of clouds, of which more attentive observation points out numerous species or subdivisions.

SECTION XIII.

Of the apparent Fragments of Nimbi called Scud.

We may observe after showers, when the nimbus appears to have spent itself, and the separate modifications reappear in their different stations, that there are loose dark flocky detachments of clouds flying along in the wind, and generally rather low down: these seem like broken fragments of the nimbus; the sailors call them Scud; they often fly along in a lower current of wind, at a time when large mountainous cumulostrati and cumuli appear more stationary somewhat higher up, and when flimsy features of cirrostratus, cirrocumulus, and cirrus are visible in a region still more elevated. When this scud is abundant we may be sure the imbriferous quality of the atmo-

sphere remains, and we may expect a return of the showers. These fragments differ in general from the flocky and nascent cumuli which feed nimbi from below during rain, in being of a darker and more nimbiform, consistency. I have been at the top of the Mountain Cader Idris when they have passed below me through the valleys. They then appeared like a dark purplish mist. But sometimes whitish fleecy cumuli of similar form sail along, and at others more compact cumuli; there being almost all conceivable varieties. These detached clouds are called sometimes by the common people Water-waggons, from being observed to supply showers or to indicate their fall.

SECTION XIV.

Of the Mixture of the Modifications.

In showery and variable weather, when there is much cloud in the sky, we observe often such a mixture of different modifications as must puzzle us to commemorate. Here and there the semiformed shapes of

cirrostratus appear in the general mass: in another place irregular cirrus or cirrocumulus; flat sheets seem to drop down into little detached clouds of freckled appearance like cirrocumuli; cumuli are seen under, and milklike whiteness spread aloft in other places. In time the dense continuity of cumulostratus prevails, and the confusion of nimbus and the fall of rain again take place. To be acquainted with all these different appearances and the different look of different skies, the meteorologist must watch them himself continually and attentively.

I am desirous of knowing whether in the equatorial and polar climates any great difference in the modifications prevails from those which happen here; from what I can collect from travellers and from drawings, there are few differences. The clouds of England and Wales are I am persuaded much the same as those of other parts of Europe. I must mention that during my stay in Wales I did not see any decided cirrocumulus; but this must have been accident; that cloud is found no doubt in all parts of Europe and in all parts probably of the world. Indeed I feel little doubt but that, with some

few variations, all our clouds prevail everywhere. Accurate journals of them kept in different parts of the world and communicated in the periodical journals would be very interesting.

SECTION XV.

Of Rain, Snow, and Hail.

I HAVE little to say of these three modes of the resolution of the nimbus, which has not been already treated of by meteorologists,* nor of their compound, commonly called sleet.

The peculiarities of rain seem principally to consist in the size, and close or distant arrangement of its streams. I have observed, that the large and distant streams of some summer showers have often a strong positive electricity. Rain has been found sometimes positively, and at others negatively, electrified; and sometimes nonelectric.

* Vid. Seneca Nat. Quæst.—Aristot. Meteor.—Des Cartes Treat. Meteor. et cæt.

The peculiarities of snow seem to consist, for the most part, in the size and shape of the flakes. Sometimes they are of a sort of stelliform figure. Hailstones vary in size and shape. Such large ones sometimes fall, as break windows, and do other mischief. Of this a memorable instance happened some years ago at Bruxelles. I think I remember to have found some round and transparent hailstones which contained opaque concentric globes in the inside. Hail and snow have generally been found electrified.*

SECTION XVI.

Of the Colours exhibited by Clouds.

It is an unfortunate circumstance, that there are no words in common use for colours, in any known language, which are sufficiently explanatory. This circumstance

* Consult the experiments of Cavallo, Comp. Treat. Elect.—Bertholon. Elec. Met. &c. See Chapter on Electricity of Clouds.

arises probably from the great variety of shades and combinations of colours which flowers and other natural and artificial productions every where display.

Clouds, as is well known, refract and reflect a great variety of beautiful tints, the shades of which vary according to their relative position with respect to the sun; but the colour seems also to depend on the kind of cloud, and the degree of its density. The cirrostratus shows the most beautiful and varied colours. Different shades of purple, crimson, lake, and scarlet, are the most common. The haze, with a horizontal sun, refracts different colours at different times; yellow, orange, more or less of a golden hue, red, and lake, are the most common; sometimes I have seen the haze refract a brownish colour. The colour varies upwards; sometimes I have seen several colours in the haze. Particulars of which may be found in my journal in Philos. Magaz. The colour of clouds should always be noted down in meteorological journals, as also the particular modification in which the colours appear. I have noticed that cirri, cirrocumuli, etc. at different times show different colours,

though in nearly the same situation with respect to the sun.*

I have often seen the nubeculae of cirrocumulus forming in beds here and there, about the time of sunset; highly tinged with crimson, or with vermillion; colours which more often affect the cirrostratus and not unfrequently the cirrus.

There is one curious circumstance worthy of notice with respect to the refraction of colour in clouds. We often notice the light clouds, cirrostrati for example, which show fine colours just above the set sun and near to the horizon at a time when they either do not appear at all over head, or do not there refract any colours. If it were only from one place that these clouds were seen near the western horizon, we might suppose that they were local, but as all over large tracts of country the same appearances would be seen probably at the same time, we must

* A systematic arrangement of colours might be made as well as of scents, by reference to flowers, and other standard substances. It would be well if we had a nomenclature for colours, which expressed them by reference to the proportion of the primitive tints of which they may be compounds.

conclude that the modification of cloud is existing every where about, but that a particular angle with respect to the sun is necessary to its being visible, or appearing as a coloured cloud.

We observe that clouds of the same variety, having the same local or angular position with respect to the sun, sometimes appear richly coloured, and at other times scarcely coloured at all; a circumstance which renders it questionable, whether the colour is from the cloud itself, or whether the cloud only reflects the light which is coloured in passing through the haze of the atmosphere in the evening? The former is however probably the case; for different clouds in nearly the same angular position with respect to the sun show different colours at the same time. But the colours refracted by the haze are very various. Sometimes the tints in the twilight haze come on so suddenly and are so circumscribed as to induce a belief that very sudden and partial changes take place in the atmosphere at eventide; which may perhaps be somehow connected with the formation of dew. It is doubtless the falling dew which refracts the colours in general, which are varied by

the position of the parts in which they are seen. There is frequently a deep golden orange close to the horizon, a crimson blush above it fading into purple and the dark blue, about it on each side a whitish transparent appearance, or a lively greenish blue; or perhaps the true light prismatic blue; and all these vary as the sun gets lower beneath the horizon. These and numerous other beautiful appearances of diverging streaks, bars, and spots may often be seen with a horizontal sun; we notice them chiefly in an evening, because we seldom rise soon enough in the morning; but they may be observed to display nearly the same degree of beauty, though with some variety of appearance, when they usher forth the gay Aurora, rising from the bed of the sable Tithonus, as when they throw their painted canopy over the declining car of Phoebus, and mark the place where he has sunk beneath the ocean, till they fade away by degrees, and are lost in the uniform gloom of Night.

SECTION XVII.

Of the Elevation of Clouds.

THE mean or average degree of elevation of the different modifications is different. According to Mr. Howard, the cirrus is the highest; the cirrocumulus next; and the cirrostratus, cumulus, and stratus, successively lower than each other. The cumulostratus, which is a compound cloud, is of vast vertical dimensions: when it forms on a cumulus, the top of it appears to rise higher, and the base generally lower, than that of the cumulus. The nimbus, which is the resolution of clouds into rain, may be considered as having its base on the earth, and its summit at the end of the fibres of its cirrose crown.

The modifications have different degrees of elevation at different times; and sometimes the order of them is inverted: many instances of which may be found by consulting journals. I have seen the cirrus in tufts moving along rapidly in the wind, below cirrocumulus, and even cumulus in

a higher region. Towards evening on Sunday, April 12, 1812, I observed from Clapton a small fibrous cirrus moving rapidly along in the wind, lower than fleecy cirrocumulus which appeared in a comparatively calm region above. There were, however, other cirri more elevated in the sky at the same time. The following spring, on Sunday, the 21st March, 1813, at Cambridge, about 11 a.m., I remarked a long cirrus moving rapidly along in a north wind, not lengthways, but abreast. At one end of it fibres pointed backward to the north, while at the other they pointed to the east. Higher up, light cumuli passed over from the south; and higher still were flimsy ill defined masses of cirrocumulative cirrostratus in an air comparatively calm, but they were found to be passing over gently from north west. Many other cases of inverted order might be noticed. Sometimes cirrocumulus may be seen under a spreading sheet of cirrus of a milky appearance, which look like a bas relief. I have once or twice noticed the nubeculae of a bed of cirrocumuli lower down to be smaller than those of one more elevated. This was noticed among the

abundance of cirrocumulus, cirrus, and other clouds, which appeared on 21st Oct. 1811: the night succeeding was cloudy, with a gale from south and distant lightning. The long lines of cirrus extending across the sky have been found to be very high, by geometrical observation. By the same mode of mensuration, I found that I was frequently much deceived in my opinion as to the height of clouds at first view of them. Saussure writes of the very great height of clouds, which from the description must be a kind of cirrostratus in mottled beds, and Dalton mentions, that the clouds of the mackerelback sky, as he calls it, have appeared almost as distant from the top of high mountains, as from the ground.* That clouds are sometimes very high, there can be no doubt: and their height may be easily taken with quadrants at different stations. Aëronauts have generally ascended much beyond the cumuli; but I question if there are not clouds much higher up than any balloons have ever ascended. Mr. Sadler mentioned to me, that large cumuli seen

* Dalton's Meteorological Essays.

by him, when at a much greater elevation in a balloon, appeared like small silvery specks on the ground; his distance from them being so great, that they appeared to rest on the earth's surface; but I have found no accurate accounts of aëronauts having ascended so far as the lighter modifications sometimes appear to be elevated.

Those who have been on the tops of high hills and mountains, have frequently spoken of clouds having passed below them; but being unacquainted with the peculiarities of clouds, and having been inattentive in their observations, their accounts have been of little value for ascertaining the general height of the modifications; when I was at the top of Cader Idris, on Sunday evening, August 14, last, the weather being cleared up after a showery morning, I noticed that the scud passed above and below the tops of the mountains, but the bases of most of the cumuli were above them; a long bed of cirrus with fine fibrous edges was much higher, so that my ascent up the mountain hardly seemed to bring me nearer to it; but the most exalted clouds of all were the flimsy cirrocumulative forms of cirrostratus. Indeed

it may often be observed that these transient features of cirrostratus, which appear in the intervals of storms, are elevated much above the tops of cumulostratus, or cumulus, which may be seen lower down. Future observations by means of trigonometrical measurement may, when the differences of clouds become more generally known, lead to a more accurate estimate of the heigth of the different varieties. In general, the regular ephemeral cumuli have much the same elevation, which somewhat increases during the day from the rising of the vapour plane whereon they float. I have made observations with a view to determine whether cumuli were not usually higher over some soils than over others, but I cannot perceive much difference in this respect; they certainly have appeared somewhat lower when over the sea, than when they have come over the land; I noticed this at Hastings, in August and September of the present year. Before rain they descend lower, increase irregularly in size, and are condensed into cumulostratus. I have noticed that when cumuli, which were flying along in the wind, have by any accidental

inosculation of the clouds, or from any other cause, changed to cumulostratus: the change has been uniformly attended with a retardation of the motion of the cloud. This probably arises from its having been increased in density in proportion to the surface presented to the wind.

SECTION XVIII.

Of the Structure of Clouds.

THE first step towards a perfect knowledge of any science, is to have an accurate and well arranged detail of particular appearances. From effects thus laid out in order, we proceed to examine what may have been their causes. It may be proper now to examine, whether the particles of clouds remain afloat in the air, or only gravitate very slowly to the ground? In other words, on what peculiarity of structure does their comparative levity depend? Experience being deficient, conjecture supplies its place, and supposes an adequate cause.

M. de Luc, and M. de Saussure, have

supposed that they may be composed of hollow vesicles;* and, in this case, if the component vesicles should contain an aëriform fluid, lighter than common air, they would become buoyant, and float in the atmosphere. It is not probable that they contain hydrogen gas. For, if they do, what can be the structure and component parts of the vesicular bag itself? It cannot be water. For, if electricity should preserve it in the vesicular form, it could not prevent the escape of its hydrogen from within. Could the bag itself be water, it would never be oxygen and hydrogen in a state of combination. The oxygen would not affect or act upon the hydrogen in the bag, because it had already combined with its due proportion of hydrogen, and become water. Nothing, then, but an accession of more oxygen could convert the contents of these vesicles into water. When the electricity is equalized, the water which composes the bag or vesicle comes down in rain; and the hydrogen, mixing with common air, may be exploded by the electric spark, or, meeting

* Idées sur la Meteorologie, par I. A. de Luc, vol. ii. p. 160.

with oxygen, may explode spontaneously, and produce one kind of lightning and thunder. This is, however, only vague conjecture: nothing is certainly known about the structure of clouds. It would make a very pretty theory, with the solution of the following questions. 1st. What are the circumstances under which hydrogen could be contained in a vesicle of water? And, 2dly. What can occasion such a separation of the gasses on a condensation of vapour into cloud? In short the opinions contained about vesicular vapour seem in general to have been vague and illfounded. That the structure of different clouds is very different, is manifest from their different refracting and reflecting powers, producing the various appearances of the halo, corona, parhelion, etc. on different occasions, as well as from the very different appearance of the clouds themselves.

But there is, in fact, no proof that the particles of water have any specific levity in the air; they may, perhaps, only gravitate very slowly to the earth, from their minuteness, as soon as from any cause the elastic vapour is condensed into a visible cloud. The manner in which such aggregates may

constitute a visible and floating cloud, which preserves or increases its elevation, has been explained by Mr. Howard in his account of the vapour plane, and the cause of the cumulus.*

SECTION XIX.

Of certain Luminous Appearances which result from the Reflection or Refraction of Light by Clouds, and which are commonly called Halos, Rainbows, Parhelia, etc.

EVERY one who is conversant in meteorology must be well acquainted with such luminous appearances, occasionally seen about the sun, moon, and planets, and caused by the refraction of their light through a cloud of peculiar structure, as are usually called halos, coronae, burrs, glories, &c. But these phaenomena have hitherto received no definite names whereby they may be distinguished from each other, though they differ considerably in appearance. Meteorologists have spoken of halos and crowns of light indis-

* Howard on Clouds, in Phil. Mag.

criminately, without distinguishing between the corona or luminous disk, and the halo or luminous ring.

The ancient writers, too, spoke indifferently of halones, circuli, coronae, halyses, parhelia, and other the like phaenomena, as appears by the works of Aristotle,* Pliny,† Seneca,‡ and others. Aristotle appears to have written with the most perspicuity of all of them.

With a view to obviate the inconvenience and misunderstanding which might arise from the confusion or promiscuous use of terms not sufficiently definite, I subjoin the following classification, which, though imperfect, may serve, till a better shall be found, to enable meteorologists, in their journals, to express, with tolerable precision, the kind of appearance which they wish to commemorate.

I endeavour to classify them (for want of a better criterion) according to the various *shapes* or *figures* which they present. It

* Aristot. Meteor. lib. iii. cc. 2, 3.

† Plin. Hist. Nat. lib. ii. cc. 29, 30, 31, 32. lib. xviii. 35.

‡ Senec. Nat. Quaest. lib. i. cc. 2, 3, 4, 5, 6, 7.

must be remembered, that their various figures are the result of the particular construction of the cloud which refracts their light: a correct attention, therefore, to these appearances, may lead to a more perfect knowledge of the structure of the refracting medium.

Halo.* Pl. VI. Fig. 1. *Circulus vel Annulus lucidus aream includens, in cujus centro Sol aut Luna apparet.*

By a halo I understand an extensive luminous ring, including a circular area, in the centre of which the sun or moon appears; whose light, passing through the intervening cloud, gives rise to the phenomenon. Halones are called *Lunar* or *Solar*, according as they appear round the moon or sun. Those about the moon are the most common. They are generally pretty correct circles: I once, however, saw a halo of a somewhat oval figure. Halones are some-

* The word *halo*, or *halos*, is evidently derived from the Greek *ἅλων* or *ἅλως*, signifying an *area*. The Latin writers appear to have spoken indifferently of halones, halyses, coronae, circuli, &c. without sufficiently distinguishing between the *corona* and the *halo*.

times coloured with the tints of the rainbow.*

HALO DVPLEX. Pl. VI. Fig. 2. *Duo Annuli, in quorum centro communi Sol aut Luna videatur.*

A double halo is not a very common occurrence. I have observed, that simple halones are generally about 45° in diameter: in case of double halo, it might be worth while to take the diameters of each of the concentric circles.

HALO TRIPLEX. *Tres Annuli, in quorum centro communi Sol aut Luna appareat.*

Triple halones are extremely rare occurrences.

HALO DISCOIDES. Pl. VI. Fig. 3. *Annulus aream reliquâ nubis parte lucidiorem continens, in cujus centro Luna aut Sol visus est.*

A discoid halo may be said to be a halo constituting the boundary of a large corona: it is generally of less diameter than usual, and often coloured with the tints of

* The coloured halo is generally seen in a denser kind of cirrostratus.

the *Iris*. A beautiful one appeared on the 22d of December, 1809, about midnight, during the passage of a *cirrostratus* before the moon.

CORONA. Pl. VI. Fig. 4. *Discus lucidus, vel portio circularis nubis reliquâ lucidior, in cujus centro Sol aut Luna videtur.*

When the sun or moon is seen through a thin cloud, a portion of the cloud, more immediately round the sun or moon, appears much lighter than the rest of it: this luminous disk, if I may be allowed the expression, I call a *corona*.

Coronae are of various sizes, according to the peculiarities of the intervening vapour: but they seldom exceed 10° in diameter: they are generally faintly coloured at their edges.

Frequently, when there is a halo encircling the moon, there is a small corona more immediately round it. Coronae, as well as halones, have been always observed to prognosticate rain, hail, or snow. As far as I can observe, they are generally seen in the cirrostratus cloud.

CORONA DVPLEX. *Discus lucidus, alium*

discum paulo lucidiorem ac minorem includens, in quorum centro communi Sol vel Luna videtur.

A double corona is very common: sometimes they are triple or quadruple.

PARHELION. Pl. VI. Fig. 5. *Imago Solis falsa, vel plures imagines ejusdem generis circa Solem circulatim dispositae, et magis minúsve halonibus aliisque lucidis vittis commitatae.*

Parhelia vary considerably in general appearance: sometimes the sun is encircled by a large halo, in the circumference of which the mock suns usually appear: these have often small halones round them: they have usually a horizontal band of white light of a pyramidal figure extending from them: sometimes a large semicircular band of light, like an inverted arch, seems to rest upon the halo which encircles the sun: but these phaenomena vary too much to be particularly described here: their peculiarities ought to be minutely observed and noted down in a Meteorological Journal.

PARASELENE. *Lunae imago falsa, vel plures imagines hujus generis circa*

Lunam dispositae, et magis minúsve halonibus aliisque lucidis vittis commitatae.

The *paraselene*, the *parhelion*, and the several kinds of *halo* and *corona*, all appear to result from the intervention of cloud between the spectator and the sun or moon, through which the light passes: but there is another well known phaenomenon, which always appears in a cloud opposite to the sun or moon; namely, the

IRIS. *Circulus maximus coloratus in nube Soli oppositâ visus, et cujus centrum centro Solis opponitur, qui, quòd portio ejus tantùm videtur, arcus adparet.*

The rainbow is an appearance too familiar to every one to need any particular description. As the halo and corona appear generally in the *cirrostratus* cloud; so the *Iris* appears always in the *nimbus*. Lunar rainbows are rare occurrences.

IRIS DVPLEX. *Duo Circuli colororati, quorum centrum commune Solis centro opponitur, qui quòd eorum portiones tantum videantur Arcus adpareant.*

Double rainbows are not unfrequent. The

order of colours in the outer one is reversed.* They are mentioned by Aratus. †

IRIS VNICOLOR. *Circulus maximus colorum excors, in nube visus, et cujus centrum centro Solis vel Lunae opponitur; qui quod portio ejus tantum videatur Arcus adpareat.*

The Iris unicolor is more properly a colourless rainbow, and appears in the mist. Such a one appeared on 20th November, 1812, in the vicinity of London. The afternoon of the same day there was a shower in which the rainbow showed the usual colours.‡

RABDI DIVERGENTES. *Radii Solis radiantes ob quandam specialis generis interpositam nubem.*

The remarkable appearance of the sun's rays, in a cloud before rain, has been alluded to by Aristotle, § Virgil, || and others.

RABDVS PYRAMIDALIS. *Portio pyramidalis lucis in nube visa, quasi ex Sole proce-*

* Arist. Meteor. lib. iii. cap. 5. † Arat. Dios. 208.

‡ Annals of Philosoph. by Dr. Thomson, p. 80.

§ Arist. Meteor. lib. iii. cap. 2.

|| Virgil Georg. lib. i. v. 445.

dens, cujus vertex diametro Solis horizontali perpendicularis est.

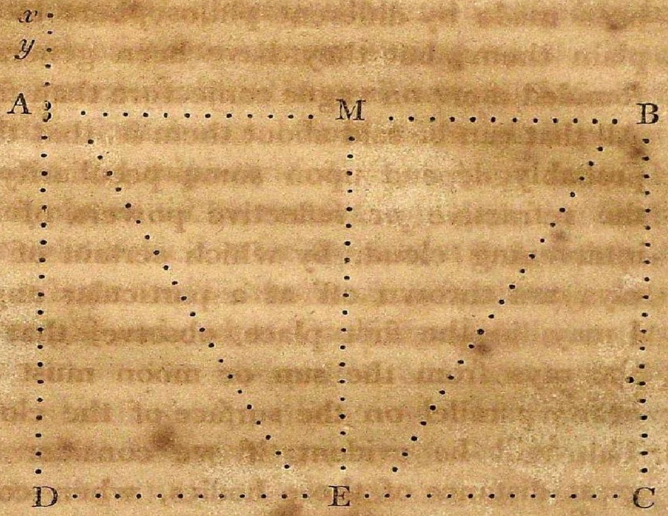
Not uncommon in haze of a peculiar kind, perhaps cirrostratus. Sometimes small portions of the rainbow's colours appear in different places. I observed this between seven and eight o'clock, 21st August, 1812, while riding between Ticehurst and Wadhurst, in the neighbourhood of Tunbridge Wells.

SECTION XX.

Of the Causes of the abovedescribed Phaenomena.

IN examining what may be the causes of the various phaenomena above described, I make a division of them into—1st, those which result from the intervention of cloud between the spectator and the luminous body. And, 2dly, those which appear in a cloud opposite to the rays of the sun or moon. Of the 1st sort are all the different kinds of halo, corona, and parhelion. Of the 2d sort are the different varieties of the Iris. With regard to the first kind of these, caused by intervention of clouds, many attempts have

been made by different philosophers to explain them; but they have been generally founded more on vague conjecture than fact. All that can be said about them is, that they probably depend upon some peculiarity in the refractive or reflective powers of the intervening cloud, by which certain of the rays are thrown off at a particular angle. I may, in the first place, observe, that all the rays from the sun or moon must fall nearly parallel on the surface of the cloud. This will be evident, if we consider the great distance of those bodies, when compared with the diameter of the largest halo. The rays which constitute the luminous ring of the halo, must be reflected at an angle equal to the angle of the semidiameter of its area; or, in other words, to the angle subtended by the distance from the sun or moon's centre to the ring. To illustrate this, I subjoin the following problem and figure.



The distance of the sun or moon from the cloud bears so great a proportion to the diameter of the halo, that the rays may be said to fall physically parallel on all parts of it; that is, if of two rays coming from the sun's centre, one should impinge on A, and the other on B, these rays might be considered as parallel. Let A B be the diameter of the halo, M the centre or place where the moon *appears*: if a ray, *x y*, proceeding from the moon in the direction *x y*, and impinging on A, should pass through the cloud in a straight line, that is, perpendicular to A B, it would appear to a spec-

tator at D. But it appears to a spectator at E; therefore it diverges from the straight line A D in the line A E, making with it an angle D A E; join M A and M E, and E D, making A D E M a parallelogram, and A E its diagonal. Then (Euc. i. 29.) the angle D A E, or angle of the aberration of the ray, is equal to the alternate angle A E M, or angle under which the semi-diameter A M of the halo A B appears.

From the above, it appears then, that a halo of 48° diameter may be ascribed to a property in the cloud of refracting certain of the rays at an angle of 24°. A double halo, the exterior ring whereof includes an area of 48°, and the interior ring whereof includes one of 10°, must be attributed to a property in the cloud of refracting certain of the rays at an angle of 24°, and certain other rays at an angle of 5°, and so on of triple ones.

A corona of 10° diameter appears to be the consequence of a property in the cloud to refract certain of the rays at every angle, from the smallest, say an angle of 1″ to 5°, beyond which the rays are refracted in the cloud, in the usual manner. A double corona the inner one of which is 5° diameter, and

the outer 10°, is referrible to a property in the cloud of refracting certain of the rays at every angle, from 1″ to 2° 30′, and certain other rays, from 2° 30′ to 5°, and so on of triple ones.*

For further particulars relative to these phaenomena, I refer the reader to the works of Aristotle,† Newton,‡ Huygens,‖ Des Cartes,§ M. Helvetius,¶ and to several papers in the Philosophical Transactions,** and Manchester's Memoirs.†† For explanation of the phaenomena of the rainbow, consult Newton's Opticks.

By the problem above it appears, that no two persons standing at any distance from each other, and looking at a halo, see the

* Even the breadth of the ring of a halo itself must be caused by a number of rays, refracted at somewhat different angles; otherwise the breadth of the ring would equal only the breadth of one ray.

† Aristot. Meteor. lib. iii. cc. 3, 4, 5, 6.

‡ Newton, Optic. 1st edit. 2d book, pp. 48, 134.

‖ Huygens's Post. Works, pp. 293.

§ Des Cartes. Treatise of Meteors.

¶ M. Helvetius. End of Mercurius in Sole.

** Phil. Trans. vol. v. 1065. xxii. 535. xxxi. 212. xxxix. 218. xlvi. 196. lii. 3.

†† Manchest. Mem. vol. iii.

same light: but as the halo is seen for a great extent around by persons in different places, a disposition to such reflexion or refraction of the rays is inferred as existing in large and extensive masses of the same cloud. It may be a fit subject of inquiry,—At what distances is halo seen at the same time? Sometimes the cloud seems very partial, but at others very extensive. When a halo appears in a cloud, the extremities of which can be seen, it may serve to mark that cloud as a subject of geometrical observation at several distant stations, whereby its distance and magnitude may be nearly ascertained.

In some parts of America halos are said to be still more common than in England.

SECTION XXI.

Evaporation.

According to the most recent theory, the following will be the process of evaporation. The accession of diurnal temperature communicating to the water the power of calorific repulsion, the production of

elastic vapour, or gas, is the consequence; which, exerting its elastic force by the repulsive power of its particles, rises into the atmosphere; but when a fluid becomes an elastic body, there is a loss of heat of temperature by expansion: and the vapour, therefore, becomes cooler than the water from which it evaporated, and also cools as it expands on its progress, causing the upper air to be cooler into which it ascends; for it has changed its heat of temperature for heat of capacity;* so that the actual temperature of the air is diminished upwards: while the said gas, possessing heat of capacity, is thus enabled to remain an expanded elastic fluid; and it is only by an actual loss of heat, from the nocturnal interception of the sun's rays, that the whole mass of atmosphere, being cooler, is then again condensed into aqueous particles, and falls in dew; by which process the heat of capacity is again changed for the heat of temperature; and the reformation of water in the form of mist or cloud, actually increases the

* I adopt the mode of expression of Sir H. Davy. See him in his Elem. of Chem. Phil. vol. i. part i. v. 1, 2, 3, &c.

thermometric warmth, in falling; and thus contributes to equalize the vespertine with the diurnal temperature, and to make the change more gradual. The formation of clouds may be regarded as dependent on circumstances which attend this process; for the rising of the elastic vapour impels that above into an atmosphere already too cold for its solution, which, therefore becomes cloud, as explained before.

As the particles of a cloud, for example a cumulus, are not believed to be kept separate by the same power of repulsion as those of elastic vapour, and as clouds are electrified, so we ascribe the mutual repulsion of their corporeal particles to that of similarly electrified bodies: now, according to Newton, where repulsion ends, there attraction begins; and if by the joint influence of these two powers, the cumulus is kept together as an aggregate, while its particles do not unite, so as to form water, we must suppose that the same principle holds good with respect to electrical attraction and repulsion. After all, these are merely theories, against which there appear as many reasons as there are for them. The inqui-

sitive mind of man is always seeking for causes, and making systems, by which even the most incredulous are liable to be misled, and to mistake imagination for truth; while the only resource of the philosopher is to arm himself with their mutual contradictions and common want of evidence, and, retracing the steps of his wandering, to sneak back into the plain regions of simple observation, and content himself to behold the variety and order of phaenomena.*

* Dew is vapour condensed into visible drops. Under whatever circumstances of diminished barometrical pressure or decreased heat the air cannot hold so much water in solution as before, the result must be a deposition of it in aqueous particles; during day and under some other circumstances of electricity, definite and floating clouds are the result, and the processes of rain often commence; but in fine weather, in the evening, the vapour plane being destroyed and the nubific principle ceasing to act, the vapour so deposited comes down in dew. The dew is not the result always of the stratus, and it differs from the wet mist of the cirrostrativeness of the lower atmosphere. The circumstances under which dew is most plentifully formed being treated of by Dr. Wells in his Essay on Dew, I refer the reader to that publication, and also to Bertholon's Elect. Met.

CHAPTER III.

OF CERTAIN ACCENSIONS WHICH APPEAR TO TAKE PLACE SPONTANEOUSLY IN THE ATMOSPHERE, CALLED FALLING STARS, METEORS, ETC.

THE igneous meteors which occasionally take place in the atmosphere, have been noticed by most of the ancient writers on natural philosophy with which we are acquainted, as may be found by the works of Aristotle,* Pliny,† Virgil,‡ Lucretius,‖ Seneca,§ and others. But the peculiarities remarkable in the different kinds of them do not appear to have been duly noticed. The most minute differences between them ought to be commemorated, together with their relation to other coexisting phaenomena: for in investigating the causes of

* Arist. Meteor. lib. i. c. 4.

† Plin. H. N. lib. ii. cc. 4, 25, 36.

‡ Virg. Georg. lib. i, 365.

‖ Lucret. de Rer. Nat. lib. ii. 206. lib. v. 1190.

§ Senec. Nat. Quaest. lib. i. c. 14.

these luminous accensions, we shall probably be assisted by observing and noting down accurately peculiarities remarkable in the different kinds of meteors which from time to time appear. The very large sort, which occasionally are seen; such, for example, as that memorable meteor which happened on the 18th of August, 1783, that which took place in November, 1803, or the large one recently observed at Geneva,* are not numerous enough to admit of being arranged under any general description; besides which, there are peculiarities in all of the larger sort, whereby each differs from every other. But the smaller kind, which appear in common, seem to me to be referrible to three principal varieties, which appear to derive their particular character from the kind of weather in which they happen.

* See Nicholson's Journal 1811.

The falling stars have generally been regarded as foreboders of wind: so Seneca in Hippolyto:

> "Ocyor cursum rapiente flamma
> Stella cum ventis agitata longos
> Porrigit ignes.

I have noticed this indication of wind particularly from the caudate meteors still to be described.

The most common sort are those very small meteors which are prevalent in clear frosty winter nights, and in summer also, when there are dry easterly winds with a clear sky. They have very much of the appearance of the real stars, and have probably, from this circumstance, derived their vulgar name: they leave little or no train behind them, and shoot along in straight lines, generally obliquely downward, but sometimes horizontally.*

The second kind are larger and more brilliant, and generally appear in warm summer evenings, particularly when cirrocumulus, cirrostratus, and thunder clouds abound: some of them are very beautiful, and give much light: they vary somewhat in colour and size. They have sometimes a curvilinear motion.

The third sort are strikingly different from the two above mentioned: they are generally small, and of a beautiful bluish-white colour; but their peculiar characte-

* I think I have observed that in summer time, when any kind of falling stars appear, some feature of cirrostratus, however small, may generally be seen about. But this does not appear to be always the case in winter.

ristic is that of leaving long white trains behind them, which remain visible for some seconds in the tract in which the meteors have gone. These tails which I have endeavoured to represent in Plate VI. Fig. 6. seem to be lost by dispersion; they appear to fly off from all points, increasing in breadth as they become fainter, till at last they cease to be distinguishable. They are generally seen in the intervals of showery weather, and are most prevalent before the occurrence of high wind: of which they have been considered by Aratus, Virgil, and other writers as a certain prognostic.*

* Καὶ διὰ νυκτα μελαιναν ὅτ᾽ ἄςερες αἴσσωσι
Ταρφέα τοί δ᾽ ὄπιθεν ρυμοι ὑπολευκαινωνται
Δειδελθαι κείνοις αυτην οδον ἐρχομενοιο
Πνευματος, &c. *Arat. Dios.* 107.

Saepe etiam stellas vento impendente videbis
Praecipites coelo labi, noctisque per umbram
Flammarum longos a tergo albescere tractus.
Georgic. lib. i. 365.

Pliny also remarks, "Si volitare plures stellae videbuntur quo feruntur albescentes, ventos ex his partibus nunciabunt." *Plin. Hist. Nat.* xviii. 35.

Compare also Lucretius de Rer. Nat. ii. 208. Theophrastus observed of old: "Οθεν ἂν αςερες διαττωσι πολλοι ανεμον εντυθεν εαν δὲ πανταχοθεν ομοιως, πολλα πνευματα σημαινουσι.
Theoph. de Sign. Vent.

These kind of meteors abounded, on the night of 10th August, 1811, after a showery day, I have thought that their tails were the result rather of some gas set on fire by the meteor in its passage, than of any of the luminous substance of the meteor left behind it. I may also remark, that if the larger kind of meteors happen at the same time that these caudate meteors are prevalent, they also leave this beautiful white and slowly evanescent tail behind them.*

* The train of light which the common meteors, or *falling stars*, appear to leave behind, and which lasts scarcely a moment, seems frequently to be an hallucination of vision, like the Δολικοσκιον εγχος sung by Homer, and quoted by Dr. Darwin, *Zoon.* sect. iii. v. 3.—to which, as well as to his paper, *De Oculorum Spectris*, I refer the reader. Mr. Aubert observed a train of reddish fire left behind the bright meteor seen at London, Oct. 4, 1783, which lasted above a minute after the meteor was extinguished. See *Phil. Trans.* vol. lxxiv. 115.

The great meteor of 18th Aug. 1783, left corruscations behind it, and moved in an irregular tract. See *Phil. Trans.* lxxiv. 114.

There are some reasons for thinking that the explosion and loud report of some meteors, and particularly of the great one of 1783, happen at the alteration of their regular course, as if interruption by explosion of hydrogen, which the meteor might meet with in its pas-

SECTION I.

Of the Causes of the Igneous Meteor, described above.

VARIOUS have been the conjectures of different philosophers about the causes of igneous meteors: their precise cause has, however, never been ascertained. M. De Luc ascribes them to certain phosphorific exhalations, which ascend from the earth, and take fire or become phospho-

sage, or from any other cause, caused the report, and division of the luminous substance of the meteor.*

There is one remarkable thing about the explosion of meteors. The great meteor of 1718 was, according to Halley, above sixty miles from the earth's surface; and yet at that elevated station the air was capable of communicating sound, as appears clear by the report of the meteor: a circumstance noticed by Arbuthnot, and by the Abbé Bertholon in his "De L'electricité des Meteors. 8vo. Lyons, 1787, vol. ii. p. 25. Where are some curious observations on the Feux St. Elme, Feux Follets, and other meteors.

* Phil. Trans. lxxiv. 20.

rescent in the air.* We shall see how this hypothesis will agree with their kind of motion, their peculiarities, and the kind of weather which precedes, accompanies, or follows them.

On the above supposition, we must regard them as taking place in the following manner. The exhalation from the earth must be a circumscribed column of some kind of volatile matter, which, when it arrives at a certain elevation, takes fire: this might easily be supposed to happen to phosphorific matter. There are several other appearances which incline one to think, that there are combustible gaseous exhalations from the earth, which afterwards ignite. The next question is, if they are only phosphorific, as M. de Luc calls them, what is the principle of their ignition? They may, perhaps, be ignited, by getting up into a dryer atmosphere. This supposition is agreeable to the known properties of phosphorus, which is preserved in water, but burns if left to dry. It may perhaps be

* Nicholson's Journal of Nat. Phil. etc. 1812.

conceived that phosphorous gasses may be preserved while passing through a humid atmosphere; but which, when they arrive at a more dry air, spontaneously take fire. The ignition being thus began, it would probably extend down the column of phosphorific vapour, and give the appearance of a descending luminous ball, just such as we see to be the case: and it might go out when it had descended again so low as to be in an air too humid for combustion. Or its extinction may, in other cases, be caused by the column of vapour being interrupted by wind, or any other cause of dispersion.

Upon the above supposition, the motion of the falling star would be exactly retrograde to that of the ascending column of posphorific matter. This is agreeable to the popular notion, that many of these meteors shoot towards the quarter from which wind will subsequently blow. Because if, as I have shown, the wind often changes first above, its current may give an inclination to the ascending column of phosphorific matter; and the burning star, moving back in an opposite direction, would point to the coming wind. This may often be the case;

but I have observed that these stars frequently shoot along in different directions: a circumstance which may be supposed to arise from their previous columns of phosphorific matter being inclined differently by different currents, which, by experiments with air balloons, I have found to exist often in the atmosphere at the same time. If these columns of phosphorific matter ascend from the earth when there are different currents of air in the atmosphere, it may be questioned, how it happens that the motion of the falling meteor is so straight, and why, on the contrary, it is not bent at angles, as its motion is retrograde to that of an ascending column of gas, which may have passed through, and received an inclination from, several currents of air? Possibly, it may be replied, between the currents there may be a deposition of water, or some other circumstance, which may extinguish burning phosphorus; and then an alteration of the current may be one circumstance that sets a boundary to its combustion, which in other cases may be continued lower. I can conceive that the change of current might interrupt the continuity of the ascending

column; and thus the star might go out when it arrived at the interception of the combustible gas. But it is hard to assign a reason why these columns of gas, if such exist, should not be dispersed entirely by the wind which they must meet with in the progress of their ascent; since they sometimes are seen when the wind is blowing very strongly below. This alone would induce one to believe, that they do not really ascend from the earth; but still they may be formed in the air, perhaps at the junction of two currents. It is moreover difficult to conceive why exhalations from the earth should arise in such narrow columns, as they must do, if this explanation of the phaenomena be true.*

If the meteors in question be caused by

* A meteor, moving in a very unusual manner, was seen at Hackney, on the night of the 7th of November, 1811, about five minutes before nine o'clock, in the North: it moved in a direction to the West: its motion was not regular in a straight line, nor in a uniform curve; but it leaped forward by successive jerks, describing a sort of undulated track; and it was of considerable magnitude: after being visible for some seconds, it apparently entered a cloud, and disappeared. The circumstance of its peculiar motion is, I think, worthy of record.

the ignition of combustible exhalations, it may be easily supposed that they would vary in appearance, according to the peculiarities of the exhaled gas. Neither is it more difficult to suppose varieties in these exhalations, than to suppose their existence at all. The columns of gas might vary in size at different times, and so give place to meteors of divers magnitudes. The greater the quantity of the exhaled gas, the less likely would it be to be wholly dispersed by the wind: it might, therefore, be carried along horizontally for miles; and, at length taking fire by dryness of the air, by electricity, or by other causes, might give place to such large, irregular, and horizontally moving meteors, which appear at uncertain intervals, and travel over vast tracts of country. But this seems to be rather an ingenious hypothesis of M. De Luc, than a theory founded on facts.

There are two circumstances about meteors, which seem to favour an opinion which I once entertained, that they are somehow connected with the combustion of hydrogen. They sometimes end with a loud report. And one kind of them is most frequent after

rain, and in stormy weather. The separation of the gasses of water has been mentioned by M. B. P. Van Mons, in a paper given to the Batavian Society. If hydrogen be thus separated, and partly mixed, as it must be, with common air, and should be ignited, we may conceive a meteor produced: but this is not sufficient to account for their long course which is generally in a slanting downward direction. The occasional report of the meteor at its termination may be supposed, however, to be caused by its meeting with hydrogen gas in its descent, and setting it on fire. This explosion, too, may interrupt the column of combustible gas, and thus put an end to the meteor.

In attributing igneous meteors to the combustion of gasses, which ascend from earth, we assume what cannot be proved: for no one has, I believe, seen such columns of combustible gas.* There are, however, some circumstances which would induce a belief

* The opinion of Aristotle about the cause of meteors seems to agree in some measure with that of M. De Luc. Consult *Arist. Meteor.* lib. i. cc. 2—4.

of their existence.* The well known meteor, called Ignis Fatuus, which appears over marshy grounds, and the electric light seen about plants hereafter to be described, which one would naturally attribute to the combustion of terrestrial exhalation, lead us to ascribe more elevated accensions to a similar cause.

* On Sunday evening, Aug. 11, 1805, I observed a very unusual exhalation from an elm tree at Clapton, in the parish of Hackney; the particulars of which are as follow. Between 6 and 7 p. m. the sky being clear, and the weather warm and dry, and wind South East, a column of darkish vapour appeared to arise from the top of an elm tree at some distance: it looked about two or three feet high: after it had continued a few seconds, it disappeared; and, after a few seconds more, reappeared; and continued in this manner, on and off, for nearly half an hour, when it became too dark to distinguish it any longer. More particulars may be found in the Gent. Mag. for 1805, p. 816.

SECTION II.

Of Aërolites.

THE large masses of substance which occasionally fall from the air vulgarly called Lunar Stones, Meteoric Stones, Aërolites, etc. of which accurate analyses have now been published, seem to be made up of ingredients composed in proportions different from those of any known terestrial compound; and are probably formed in our atmosphere; at least such is my opinion, the result of an examination of all the evidence I have been able to collect on the subject. These terrific thunderbolts of Jupiter seem in general to have come down to the earth accompanied by such loud explosions, blazes, and other circumstances as in a less degree attend the larger sort of fiery meteors. Indeed all these meteors may be owing to some common principle of chemical action going on in the higher regions of the atmosphere; which, when more gentle and slow, may only cause the blazing meteors; but which, when more intense, may go on to

consolidate large masses of newly composed substance, and may manifest itself by the fall of aërolites. I see no necessity for supposing with Aristotle and M. De Luc that the gasses, to form the meteors, should ascend from the earth, nor any proof of their ascent; but it may be by means of gasses somewhere formed aloft and taking fire that the meteoric stones are formed. The way in which electricity may be concerned in their processes is at present unknown: and the number of accounts of the fall of these stones, and of hypotheses about their causes, are too numerous to render a detail of them here of any utility. I merely wish to call the attention of meteorologists to the apparent similiarity of principle of those blazing meteors which are, and of those which are not, visibly attended with the fall of aërolites.*

* For analyses of aerolites, see Thomson's System of Chemistry, Phil. Mag. etc. For further particulars see also the Chap. on Electricity.

CHAPTER IV.

OF INDICATIONS OF FUTURE CHANGES OF WEATHER.

ONE of the principal uses of meteorology is, that it enables us to predict, in some measure, the ensuing changes of the weather. To do this accurately, a familiar acquaintance with the modifications of the clouds, and indeed with all the operations which are going on above, appears necessary. I hardly need lay down the following rule for predicting atmospheric changes, That when two or more contrary indications appear, the result must be deduced from those which ultimately prevail; and that when several agreeable signs appear, the event may be considered as predicted with additional certainty.* Prognosticks of wea-

* A rule laid down of old and sung by Aratus, who says of Prognosticks,

Τῶν μηδεν καλοκνησο καλον, δ'επι σηματι σημα
Σκεπτεσθαι, μελλον δε δυοῖν, εις ταυτον ἰοντοιν
Ελπωρὴ τελεθοι· τριτώ δε ες θαρσησειας.

Arat. Dios. 412.

ther may be divided into those which result from the observance of the sky, and of meteorological instruments; and those which are deducible from the motions and habits of particular animals, plants, etc.

The popular prognosticks of rain, wind, and other changes of weather, which with little variety are common in most countries, seem to have been known and observed with accuracy of old. Indeed their being familiar to almost every age and country affords the strongest confirmation of their correctness, to those who have not had constant experience of them. Although we find familiar mention of the signs of the weather among almost all the oriental writings, yet Theophrastus, the Grecian naturalist, seems to have been the first who cultivated this branch of meteorological science, and collected together the proverbial rules of judging of the weather; which were shortly afterwards put into verse by Aratus the poet in his Διοσημεια, above two thousand one hundred years ago, and are imitated by Virgil, Lucan, Pliny, Seneca, and others. With little variation, the same rules are found scattered among numerous works of natural history and

and science. And they are popular among the lower classes of modern Europe. Such of them as I have collected by occasional conversation with persons who spend their lives chiefly out of doors, and who are attentive in noticing their prognosticks, or what I have noticed myself, I have here collated with the written accounts of the ancients.

SECTION 1.

Of Prognosticks of Atmospheric Changes, deducible from the Motions of Animals.

IT was long ago observed by the ancients that, from the peculiar motions and habits of many animals, the consequence, probably, of their sensations of pain or of pleasure, a very accurate judgment might be formed of the approaching changes of the weather; neither has this entirely escaped the notice of more modern meteorologists. But I think they have not bestowed that share of attention to this subject which it certainly deserves. It is difficult, perhaps, to conceive the manner in which animals become sensible of the approach of particular kinds of weather. We

cannot suppose that they are forewarned of it by the appearances of the sky, at least in many cases; for some animals express signs of uneasiness previous to an alteration of the weather, long before there are any visible signs of change, and often when they have no opportunity of observing what is going on abroad. Dogs, for instance, closely confined in a room, frequently become very drowsy and stupid before rain. They often sleep all day before the fire, and are almost incapable of being roused.* The same, in a less degree, is observable in cats. And a leech, confined in a glass of water, has been found, by its rapid motions, or its quiescence, to indicate wet or fair weather. From an examination of the structures of the brain of animals, they do not appear organized to have any notions of causation; but they observe that two things are together, or follow one another; thus from one they anticipate and prepare against another. Their prognostication, however, of weather seems to result rather from some impressions on

* On such occasions, I have sometimes found their ears considerably inflamed, a common symptom of ill-health in many animals.

their feelings, than from any observation of what is going on in the sky.* Peculiarities in the electric state of the atmosphere may, I think, be supposed to affect the constitutions of animals in the same manner as they appear to do ours, and may thereby excite pleasurable or uneasy sensations.†

Rain may be expected, when the swallow flies low, and skims backward and forward over the surface of the earth and waters, frequently dipping the tips of its wings into the latter.‡

* It is a pity that among all our works of comparative anatomy, we have actually no accounts of the structure and organs of the brain of different animals. The discoveries of Gall and Spurzheim seem likely to throw some light on this most interesting part of natural history.

† "Haud equidem credo quia sit divinitus illis
Ingenium, aut rerum fato prudentia major;
Verum ubi tempestas et coeli mobilis humor
Mutavêre vias, et Jupiter uvidus austris
Denset erant quae rara modo, et quae densa relaxat,
Vertuntur species animorum, et pectora motus
Nunc alios, alios dum nubila ventus agebat,
Concipiunt; hinc ille avium concentus in agris
Et laetae pecudes et ovantes gutture corvi."

Virgil. Georg. lib. i.

‡ Among the signs of rain, Pliny enumerates *Hirundo tam juxta aquam volitans ut penna saepe percutiat.* See also Obser. Brum. Retr. Swal. 3d. Edit. London, 1818.

When bees do not go out as usual, but keep in or near to their hives,* or when ducks, gee-e, and other water fowl, are unusually clamorous, we may also expect wet.

Before rain, swine, as well as poultry, appear very uneasy, and rub in the dust.

Before and during rain, ducks, geese, and other fowls wash and dive in the waters more than usual. Pidgeons also wash before rain; and cats wash their faces; they have been observed also to scratch the bark off trees. In autumn, flies sting and become unusally troublesome.

Dogs, and other domestic animals, likewise express signs of uneasiness, and are very sleepy and dull before rain and snow. Dogs are said to dig great holes in the ground in rainy weather. We had a dog always busy in digging deep caverns in

* "Nec vero a stabulis, pluvia impendente recedunt
Longius, aut credunt coelo adventantibus Euris
Sed circum tutae sub moenibus urbis aquantur,
Excursusque breves tentant."

Virg. Geor. lib. iv. 194.

Ἢ λιμνην περὶ δηθα χελιδονες ἀΐσσωσι.
Γαςρι τυπλουσαι ἀυτως ειλυμενον ὓδῶρ.

Arat. Dios.

Theophrastus observes as a sign of rain χελιδονες τῃ γαςρι υπλουσι τας λιμνας. Linnaeus also notices this prognostick shaking of hirundo rustica.

the earth which he laid in during particular kinds of weather. This dog was a cross breed between a pug and terrier, remarkable for his sagacity.

If abroad, after long continued dry weather, when the sky is thickening, and rain approaching, we may frequently observe the cattle stretching out their necks, and snuffing in the air with distended nostrils; and often, before storms, assembled in a corner of the field, with their heads to the leeward.*

The loud and continued croaking of frogs heard from the pool; the squalling of the pintado† and the peacock, and the appearance of spiders crawling on the walls more than ordinary, and the coming forth of worms, have also been considered as signs of rain. Most of these have been noticed by Virgil, who has likewise added several more, which have never fallen under my notice,‡ but which

* Boves coelum olfactantes seque lambentes contra pilum. *Plin. Hist. Nat.* xviii. 35.

† This bird is called the comeback in Norfolk, and regarded as the invoker of rain. It often continues clamorous throughout the whole of rainy days.

‡ —— " Numquam imprudentibus imber
Obfuit, aut illum surgentem vallibus imis
Aeriae fugere grues, aut bucula coelum

have been mentioned by many writers, both ancient and modern:* When cocks crow at uncommon hours, and clap their wings a great deal, it is said to be a sign of rain; as is the appearance of the redbreast near houses.

Suspiciens patulis captavit naribus auras
Aut arguta lacus circumvolitavit hirundo
Et veterem in limo ranae cecinere querelam.
Saepius et tectis penetralibus extulit ova
Augustum formica terens iter, et bibit ingens
Arcus, et e pastu decedens agmine magno
Corvorum increpuit densis exercitus alis.
Jam varias pelagi volucres et quae Asia circum
Dulcibus in stagnis rimantur prata Caystri
Certatim largos humeris infundere rores
Nunc caput objectare fretis nunc currere in undas
Et studio incassum videas gestire lavandi,
Tum cornix plena pluviam vocat improba voce
Et sola in sicca secum spatiatur arena
Nec nocturna quidem carpentes pensa puellae
Nescivere hyemem testa quum ardente viderent
Scintillare oleum et putres concrescere fungos.

Virg. Geor. lib. 1. 392.

* —— Cornicum ut saecla vetusta
Corvorumque greges ubi aquam dicuntur et imbres
Proscere et interdum ventos aurasque vocare.

Luctet. de Rer. Nat. v. 1085.

Et quum terrestres volucres contra aquam clangores dabunt, perfundentes sese, sed maxime cornix.

Plin. xviii. 35.

Rava fulix itidem fugiens e gurgite ponti
Clamans nunciat horribles instare procellas
Haud modicos tremulo fundens ex gutture cantus

Sparrows chirp particularly loud during rain, and often begin before it falls, affording thereby for some time previously a prognostick of its coming.

If toads come from their holes in great numbers; if moles throw up the earth more than usual; if bats squeak or enter the houses; if asses shake their ears and bray much; if hogs shake and destroy the cornstalks; if oxen lick their forefeet, or lay on their right side; or if mice contend together or squeak much, according to many authors we may expect rain. Sheep and other cattle gamboling or running about and appearing very uneasy also portend rain.

Sometimes previous to rain sheep and goats seem more desirous to graze, and quit with reluctance their pastures.

Saepe etiam pertriste canit de pectore carmen
Et matutinis acredula vocibus instat
Vocibus instat et adsiduas jacit ore querelas
Quum primum gelidos rores Aurora remittit
Fuscaque nonnumquam cursans per littora cornix
Demersit caput et fluctum cervice recepit.

Cicero ex Arat. de Div. lib. 1.

Ηπου και λακέρυζα παρ᾽ ἠιόνι προυχουσῃ
Χειματος αρχομενου χέρσῳ υπεκυψε κορωνη.

Arat. Dios. 217.

See also Aelian de Anim. viii. 7.

Among other things the activity of ants in carrying about their eggs,* the voice of the solitary crow,† and the frequent immersion of many water fowl‡ have been considered as indications of rain. The garrulity of crows, ravens, rooks, and other birds of this sort, is indeed well known; "corvus aquat" is a proverb cited by Erasmus. But we must distinguish between the voice of the raven before rain, perched solitary on a tree and uttering a harsh cry, from his deep and peculiarly modulated voice when sailing round and round high up in the air before and during serene weather.‖ The raven as well as other birds often soars at an elevation much beyond what we are apt to imagine. When at the top of Cader Idris near Dolgelly I observed these birds flying considerably above the summit of that mountain on which I sat.

The hooting and screeching of owls often

* Formicae concursantes aut ova progerentes.—*Plin.*

† Horat. Carm. lib. iii. Od. 17. l. 13.—Od. 27. l. 9. —Claudian. xv. 493.—Lucan. v. 555.

‡ Plin. lib. xviii. 35.—Arat. Dios. 210.—Homer. Il. β. 461.—Varr. Frag. Catelect.

‖ For numerous collateral passages about this and other prognosticks I must refer to my edition of the Diosemeia of Aratus.

indicates a change of weather. They hoot in fact during variable weather: when fair is about to be changed for wet, or wet for fair, a similar disturbance of their feelings from atmospherical causes probably makes them hoot. Refer to Virgil's observation in Georg. lib. 1. and Professor Heyné's note on them. Authors have added, the snapping of the flame of a candle or lamp, mentioned by Aratus and Virgil, as a sign of wet.

Hesiod mentions the singing of a bird, which he calls κυκκυξ, as foreboding three days' rain; and a Leipzick editor renders the word cuculus; on what authority I know not.*

The missile thrush, turdus viscivorus, frequently sings particularly loud and long before rain. I have known this bird sing throughout a severe storm. It is from this circumstance called the storm fowl.

Mariners at sea expect a storm when the procellariae pelagicae, or stormy petrels,

* Ἡμος κυκκυξ κοκκυζει δρυος εν πετάλοισι
Το πρῶτον, τρεπει τε βροτους επ' επειρονα γαῖαν,
Τημος Ζευς ὕοι τριτω ηματι μηδ' αποληγοι.
Hesiod. Op. et Dies. 488.

shelter themselves in numbers under the wake of the vessel.*

Pennant observes that on the Island of St. Kilda the procellaria glacialis is very useful in foreboding the direction of the wind. When these birds return to the land in numbers there will be no west wind for a long time; when, on the contrary, they return to the ocean a west wind is expected.† Several prognosticks of storms are mentioned by the old Greek writers which are not observed on our shores, neither do we know exactly what birds they alluded to. I have observed that previous to windy weather pigs seem very uneasy and running about throwing up their heads and squeaking.

Magpies before and during wind fly about in small companies, and make a fluttering noise.

When the seagulls come in numbers to shore, and make a noise about the coast; or when, at sea, they alight on ships, the sailors consider it a sure foreboding of a storm. These circumstances were known of old.‡ Before storms, too, the porpus,

* Bewick's Birds, 2nd vol. of Waterfowl. 224.

† Pennant's Arctic Zool.

‡ Virg. Geor. lib. 1.—Plin. lib. xviii. c. 35.

dolphin, and grampus, come to the shore in large bodies.

When dolphins play about the surface of a calm sea, Pliny observes wind may be expected from that quarter from which they have come.* Authors have added tame swans, flying against the wind, as a sign of rain.

SECTION II.

Of Prognosticks of Weather taken from the Observance of Plants and Flowers, etc.

In the oeconomy of nature we find that plants, like animals, adapt their motions to their wants: some expand their flowers to the sun, and close them at eventide; others expand their flowers in the evening, open before rain, or perform various other functions, the result of their particular natures, and to which the varying states of the atmosphere are specific stimuli. From an accurate and constant observance of these many prognosticks of the ensuing weather have been deduced; of which I insert the following,

* Plin. Hist. Nat. lib. xviii. 35.

rather on account of their popularity, than because I have noticed many of them myself.

Chickweed has been said to be an excellent weatherguide: when the flower expands freely, no rain will fall for many hours; if it so continues open, no rain for a long time need be feared. In showery days the flower appears half concealed, and this state may be regarded as indicative of showery weather; when it is entirely shut we may expect a rainy day.

If the flowers of the Siberian sowthistle remain open all night, we may expect rain next day.

Before showers the trefoil contracts its leaves,* as does the convolvulus and many other plants.

Lord Bacon observes that the trefoil has its stalk more erect against rain.

There are many plants whose flowers are opened at particular periods of the day, as the *tragopogon porrifolium* and *pratense*; which open their flowers earlier or later, according to the state of the weather.

Lord Bacon mentions a small red flower, growing in stubble fields, called by the

* Plin. Hist. Nat. xviii. 35.

country people wincopipe, which if it opens in the morning ensures us a fine day.

To these, the closing of the flowers of the pimpernel, and numerous other prognosticks, might be added, but it would swell this section beyond its limits.*

SECTION III.

Of the Prognosticks of Weather from the Appearances of the Sky.

After clear weather the appearance of light streaks of cirrus in the sky is often the first sign of a change. These increase, descend, become cirrostrati, cumuli form underneath and inosculate, and nimbus and rain are the event of the process begun by fine filaments of the cirrus.

When the cirrus is seen in detached tufts, called Mares' Tails, it may be regarded as a sign of wind, which follows often blowing from the quarter to which the fibrous tails have previously pointed. The change from cirrus to cirrostratus, and indeed

* The reader may consult Lord Bacon's Sylva Sylvarum, cent. ix. cap. 823—830.

the great prevalence of the latter cloud at any time must be regarded as an indication of an impending fall. The most formidable features of cirrostratus are the large spreading and dense sheets of it which veil the sky before rain, and in which the sun often sets shrouded against a rainy day.

The prevalence of clouds of the modification of cirrostratus at eventide had been noticed as a sign of rain long before the specific nature of the different clouds was attended to; and the vivid colours of red and crimson seen in this cloud when the sun is near the horizon, give rise to many proverbs about the red evening, and its favourable omen to the traveller; a remark quite as trite among country people, as the grey morning before a fair day. This, as well as the redness of the morning, as indicative of a fair day, is noticed by St. Matthew, in chap. xvi. 2. Dappled grey mornings, or those marked by the lofty confluent nubeculae of cirrocumulus, often usher in a fair warm day.* Indeed the appearance of

* An old proverb reminds us,

An evening red, and a morning grey,
Are sure signs of a fine day;
But an evening grey, and a morning red,
Put on your hat, or you'll wet your head.

cirrocumulus in general indicates an increase of temperature. Heyne, in his edition of Virgil, speaks of them as being called ovicúlae or little sheep, from their appearance, and as indicating fair weather.*

The denser features of cirrocumulus, or those whose nubeculae are dense, compact, round, aggregate, are generally indicative of a storm.

Before storms too a feature of cirrostratus appears, of a cymoid figure, like some architectural ornaments. Pl. IV. Fig. 1.

It is generally in variable weather that a line of cirrostratus breaks out into transverse bars, as in Pl. II. Fig. 2.

The irregular increase of cumuli, particularly toward evening; and in general their not subsiding in the evening, may be regarded as a forewarning of wet.

The Italians have:

Sera rosa e nigro matino
Allegra il Pelegrino.

* Among the many rules, such as are contained in our old almanacks, we find

If woolly fleeces strew the heavenly way,
Be sure no rain disturb the summer day.

Virgil and Aratus, however, made the *vellera lanae* rainy signs, and meant, do doubt, cirrus, or cirrostratus.

When cumuli sailing along have their fleecy protuberances curling inward, variable weather may be expected, such cumuli often rapidly anastomose with cirri or cirrostratus above them, and produce showers.

When a dense and uniform veil of cloud covers the sky, as is often the case before rain, with a still air, musick and noises are heard a great way off, which has caused the far propagation of sounds to be regarded as a prognostick of rain. The sound of distant church bells in the country often serves this prognosticative purpose.

In Wales the common people say, that when the mountains have their nightcaps on, the rain will soon fall.

While I was in Wales during a showery time, the peaks of the mountains were generally capped with clouds of the low and nimbiform kind. The clearness of the tops of mountains is, on the contrary, a sign of the fairness of the weather. Long cirrostrati and other elevated clouds often alight on the summit of real mountains, as they do on mountainlike cumulostrati, and are equally indicative of wet weather.

When the rapid formation and disappear-

ance again of clouds take place in fine days, as is often the case, we may suspect the serenity we enjoy, and look forward to a change. I have seen little cumuli form and disappear in the space of a few minutes; and cirrus form, change its figure to spots of cirrocumulus, and disappear at the same time at a more elevated station.

Luminous phaenomena about the sun by day, or the moon by night, being generally produced by the intervention of cirrostratus, indicate the fall of rain, snow, or hail, according to circumstances; indeed, many of the signs of rain are likewise under other circumstances of time of year, &c. prognosticks of snow. The halo is one of the most certain signs of rain we have; though I have even known this fail in its accustomed indication. The parhelion and other peculiar refractions also forebode rainy weather.*

The simple corona often occurs in many kinds of thin clouds, and frequently without any rain following; but we may generally expect wet when it is coloured, double, or

* Consult Arist. Meteor. lib. iv. cc. 3—6; the Dios. of Aratus; the Natural History of Pliny; the Natural Quest. of Seneca, etc.

with any remarkable peculiarities. We do not know at present under what peculiar circumstances halones and coronae are coloured; but it must be done by something particular in the structure of the cloud which produces them.

The halo appears at times in a sky where there is little or no visible obscuration, the interstitial space between the rings seems quite blue, like the sky in general. Some very fine diffused haziness, perhaps cirrostratus, however produces by refraction the white ring of the phaenomenon. We often find on such occasions the light of the stars dim, and a more complete obscuration, and eventually rain to follow. Pliny has noticed this obscuration of the light of the sun by day, and of the stars by night, without any definite cloud, to forebode rain, as had been before mentioned by the more ancient writers.*

The rainbow, which is only an effect

* See Plin. Hist. Nat. lib. xviii. c. 35. The rain which falls under such circumstances is gentle and of long continuance, and often extends a great way. The vulgar prejudice, however, about the extent of rain in general is quite unfounded. H. Culhwe Mabinogion, in allusion to this:—Ti á gefi y cyvarws a noto dy ben á th davawd, hyd y syc gwynt, hyd y gwlyc, gwlaw hyd y treigl haul a hyd yz amgyfred môr.

of nimbus, has been regarded as a sign of rain; which it may rightly be, for it often appears in the nimbus before that cloud, weeping in his sable shrowd, has reached the spot where we stand. *Bibit ingens arcus*, says the Mantuan bard, who took most of his prognosticks from the Diosemea of Aratus.*

Of the particular indications of the haze in the atmosphere we may notice, that the mere hazy or pale colour of the moon often forebodes rain, while she is more brazen, red, or copper coloured before wind. This corresponds with the red in the clouds, before noticed as a sign of wind.

SECTION IV.

Of several other Prognosticks of Rain, and of the Return of fair Weather.

Many indications of atmospheric changes have been noticed by different authors, which

* Η διδυμη ἐζωζε διὰ μεγαν ὀυρανον ἰρις
Η καὶ που τις αλωα μελαινομενην, εκει αςηρ.
Arat. Dios. 210.
See also Virgil, Geor. i. 380. Platus Curcul. Statius Thebaid, ix. 405.

I have not determined by my own observation to be correct, such, for example, as the smell of drains and suspools; the excrescence of fungi about the wicks of lamps and candles; the flaring and snapping of the flame; the soot taking fire in sparks round the smoky outside surface of a pot on the fire; the wicks of candles not being easily lighted, and many others of this sort. Wind has been indicated by candles burning unequally, or by coals casting off more ashes than usual.

Pain felt in limbs formerly broken, or in other injured parts of the body, often forebode rain. In the summer of 1813, the extensor tendon of my forefinger was divided by accident, and though by means of a new substance interposed between the divided ends of the tendon, its functions were restored, and the wound completely healed, yet I always feel an uneasy sensation in it before rainy weather, very similar to that which I experience after having much exerted it.

The cumulostratus being a state of the clouds going on to become nimbus, has been regarded as one of the rainy signs, and given rise to the following adage:

"When clouds appear like rocks and towers,
The earth's refreshed by frequent showers."

SECTION V.

Of Indications of the Return of Fair Weather.

THE absence of those circumstances which forebode or accompany foul weather may generally be considered as indicating a return of fair. So Virgil mentions the clear and bright appearance of the moon and stars, after they have long been hazy and confused, to indicate approaching serenity.* Every one is acquainted with the additional clear-

* Nec minus ex imbri soles et aperta serena
Prospicere et certis poteris cognoscere signis
Nam neque tum stellis acies obtusa videtur
Nec fratris radiis obnoxia surgere luna
Tenuia nec lanae per coelum vellera ferri
Non tepidum ad solem pennas in littore pandunt
Delectae Thetydi halcyones, non ore solutos
Inmundi meminere sues jactare maniplos.
At nebulae magis ima petunt, campoque recumbunt;
Solis et occasum servans de culmine summo
Nequidquam seros exercet noctua cantus.
Virg. Geor. i. 403.

Tum liquidas corvi, presso ter gutture voces
Aut quater ingeminant, et saepe cubilibus altis
Nescio qua praeter solitum dulcedine laeti
Inter se foliis strepitant juvat imbribus actis
Progeniem parvam dulcesque revisere nidos.
Virg. Geor. i. 414.

ness of a night intervening between wet and clear frosty weather. By the general disposition of the clouds, we may, in general, prognosticate fair or rainy weather. In the most settled weather, only diurnal cumuli appear; they are well defined, increase towards the middle of the day, and decrease at night. Of this enough has been already said in the chapter on the clouds. The brightness and heat of the fire in winter often indicate frosty and clear weather, as does the lodgment of the moisture on the windows; for it demonstrates a cold and frosty atmosphere abroad.* To the above signs of atmospheric changes, many others might be added; but to enumerate all which different authors have mentioned, would swell too much this chapter, and I must refer the reader, for further information on this subject, to the chapter on superstitions originating in meteorological phaenomena, wherein I have collected and inserted more of these trite

* See the *Shepherd of Banbury's Calendar*, London, 1748.

Lord Bacon has adduced many conjectures why herons flying high forebode wind, and kites doing the same, fair weather.

and ancient sayings about the prognosticks of the weather.

SECTION VI.

Of the Prognosticks of Seasons.

THE constant desire to know what is about to happen, which our natural curiosity and the interest we take in future events occasion, added to the use which agriculturists and farmers may make of some knowledge of the approaching weather, have always rendered men very attentive to the signs of the seasons; and made them watch attentively for those circumstances from which experience had taught them to anticipate severe winters, hot summers, late springs, plentiful autumns, and other vicissitudes of the year.

Lord Bacon, who was so well calculated to observe and compare facts, collected numerous prognosticks of this sort, which are recorded among his works on natural history. I shall mention a few of these as subjects

for future observation; though, as far as my own experience goes, the cases of exception are nearly as numerous as those which correspond with the rules. According to Bacon, a moist and cool summer bodeth a hard winter; a hot and dry summer and autumn portendeth an open beginning of the winter, and a cold midwinter and spring; an open and warm winter presageth a hot and dry summer, particularly when there are winter showers.

The earlier or later appearance of birds of passage is said to correspond with the earlier or later commencement of the seasonable weathers; and to afford thereby a prognostick. But for many years I have observed that this is not precisely the case with the swallow tribe. If it were generally true it would tend to establish a connexion between the weather of places where the birds come from and that of those countries whither they go. But when the later appearance of migratory fowls accompanies late seasons, it is probably because the cold unseasonable weather compels them to hide themselves and prevents their coming abroad and being seen. The occasional early appear-

ance of a single swallow has been proverbially noticed as not being indicative of summer.*

Mr. White in his Natural History of Selborne has given a list of the times of the first appearance of migratory birds for several years: and I have given tables of their appearance in Nicholson's Phil. Jour. and in my Observations on the Brumal Retreat of the Swallow, 3d edit. Appendix; whereby the reader, by comparing the birds' appearance with the seasons, may obtain some information on this point.

The abundance of berries in the hedges is said to presage a hard winter, but this often fails.

* It is remarkable, that most countries have a similar proverb relating to the swallow's accidental appearance before its usual time. The Greeks have Μία χελιδὼν ἔαρ οὐ ποιεῖ; the Latins, Una hirundo non facit ver; the French, Une hirondelle ne fait pas les printems; the Germans, **Eine schwalbe macht keinen fruling**; the Dutch, Een swaluw maakt geen zomer; the Swedes, En svala gör ingen sommar; the Spanish, Una golondrina no hace verano; the Italians, *Una rondine non fa primavera*; and the English, One swallow doth not make a summer.

SECTION VII.

Of Solar and Lunar Influence.

THE influence of periods of day and night on many diseases which have been incontrovertibly proved, and the recurrence of many after certain intervals of time, show that there is some truth in the notions of many physiologists about periodicity; and that this is probably effected by means of some unknown changes produced in the weather. We do not know yet what regulates atmospheric changes in general; how electricity becomes so distributed as to produce those various effects which analogy leads us to ascribe to it; in short, we have no good general theory of meteorology, as we have of astronomy, mechanics, &c. The old notions of astrologers about the conjunctions of planets involve too many palpable absurdities to allow us to collect any useful information from their writings.

But it is certain the place of the moon has some influence on the weather. That changes of weather oftner take place about

the full and new moon and about the quadratures, than at other times, is really a fact founded on long observation.*

SECTION VIII.

Proverbs relating to the Months, Seasons, etc.

PROVERBIAL phrases and adages are generally founded on observation, and these are the less likely to be compared with false and vain theories, because they are the philosophy of the unlettered hinds, who have nothing but experience to go upon in establishing rules. That the reader may judge from time to time how far any of these are correct, and may compare them with his own experience, I insert the following, most of which were collected by Ray.†

* A Proverb says:

In the decay of the moon
A cloudy morning bodes a fair afternoon.

Also. Rain in the new moon, fair in the old. &c. See *Ray's Collection of Proverbs, and E asmi Adagia.*

† See also an entertaining book called Time's Telescope, published in 12mo. in London last year, p. 358.

Janiveer freese the pot by the fire.
If the grass grow in Janiveer,
It grows the worse for't all the year.

Who in Janiveer sows oats, gets gold and groats;
Who sows in May, gets little that way.
If Janiveer calends be summerly gay,
'Twill be winterly weather till the calends of May.

On Candlemasday throw candle and candlestick away.
When Candlemasday is come and gone,
The snow lies on a hot stone.

February fill dike, be it black or be it white:
But if it be white, it's the better to like.

Februeer doth cut and shear.

The hind had as lief see his wife on the bier,
As that Candlemasday should be pleasant and clear.

February makes a bridge, and March breaks it.

March in Janiveer, Janiveer in March I fear.

March hack ham, comes in like a lion, goes out like a lamb.

A bushel of March dust is worth a king's ransom.

March grass never did good.

A windy March, and a rainy April, make a beautiful May.

A March wisher is never a good fisher.

March wind and May sun, make clothes white and maids dun.

So many frosts in March, so many in May.

March many weathers.

March birds are best.

April showers bring forth May flowers.

Chaucer writes in his Canterbury tales:—

When that Aprilis with her showery soote
The droughte of March had pierced to the roote.

When April blows his horn, it's good both for hay and corn.

A cold April the barn will fill.

An April flood carries away the frog and her brood.

A cold May and a windy, makes a full barn and a findy.

The merry month of May.

April and May are the keys of the year.

May, come she early or come she late, she'll make the cow to quake.

Beans blow before May doth go.

A May flood never did good.

Look at your corn in May, and you'll come weeping away.

Look at the same in June, and you'll come home in another tune.

Shear your sheep in May, and shear them all away.

A swarm of bees in May is worth a load of hay;
But a swarm in July is not worth a fly.

Calm weather in June sets corn in tune.

If on the eighth of June it rain,
It foretells a wet harvest, men sain.

If the first of July it be rainy weather,
'Twill rain more or less for four weeks together.

A shower in July, when the corn begins to fill,
I's worth a plough of oxen, and all belongs there till.

No tempest, good July, lest corn come off blue by.

Dry August and warm, doth harvest no harm.

If the twentyfourth of August be fair and clear,
Then hope for a prosperous autumn that year.

September, blow soft, 'till the fruit's in the loft.

Good October, a good blast,
To blow the hog acorn and mast.

November take flail, let ships no more sail.

When the wind's in the east, it's neither good for man nor beast.

When the wind's in the south, it's in the rain's mouth.

When the wind's in the south,
It blows the bait into the fishes' mouth.

No weather is ill, if the wind be still.

A hot May makes a fat churchyard.

When the sloetree is as white as a sheet,
Sow your barley whether it be dry or wet.

A green winter makes a fat churchyard.

Hail brings frost in the tail.

A snow year, a rich year.

Winter's thunder's summer's wonder.

Drought never bred dearth in England.

Whoso hath but a mouth, shall ne'er in England suffer drought.

When the sand doth feed the clay,
England woe and welladay.

But when the clay doth feed the sand,
Then it is well with England.

After a famine in the stall,
Comes a famine in the hall.

When the cuckoo comes to the bare thorn,
Sell your cow, and buy your corn:

But when she comes to the full bit,
Sell your corn, and buy your sheep.
If the cock moult before the hen,
We shall have weather thick and thin;
But if the hen moult before the cock,
We shall have weather hard as a block.

As the days lengthen, so the cold strengthens.

If there be a rainbow in the eve, it will rain and leave.
But if there be a rainbow in the morrow, it will neither leed nor borrow.

A rainbow in the morning
Is the shepherd's warning.
But a rainbow at night
Is the shepherd's delight.

When the clouds are upon the hills, they'll come down by the rills.

Winter's thunder, and summer's flood,
Never boded Englishman good.

If Candlemasday be fair and bright,
Winter will have another flight:
If on Candlemasday it be shower and rain,
Winter is gone, and will not come again.

I insert in conclusion the well known rules of the Shepherd of Banbury.

If the sun rise red and fiery, wind and rain.*
If cloudy and it soon decrease, certain fair weather.

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* The same is observed of the moon, of whose three several indications the adage says,

Pallida luna pluit, rubicunda flat, alba serenat.

Clouds small and round, like a dapple grey with a north-wind, fair weather for two or three days.

Large clouds like rocks, forebode great showers.

If small clouds increase, much rain.

If large clouds decrease, fair weather.

Mists, if they rise in low ground and soon vanish, fair weather.

If mists rise to the hilltops, rain in a day or two.

A general mist before the sun rises, near the full moon, fair weather.

If mists in the new moon, rain in the old.

If mists in the old, rain in the new.

Observe that in eight years time there is as much southwest wind, as northeast, and consequently as many wet years as dry.

When the wind turns to northeast, and it continues two days without rain, and does not turn south the third day, nor rain the third day, it is likely to continue northeast, for eight or nine days, all fair; and then to come to the south again.

If the wind turns again out of the south to the northeast with rain, and continues in the northeast two days without rain, and neither turns south, nor rains the third day, it is likely to continue northeast for two or three months.

After a northerly wind for the most part two months or more, and then coming south, there are usually three or four fair days at first, and then on the fourth or fifth day comes rain, or else the wind turns north again, and continues dry.

If the wind returns to the south within a day or two without rain, and turn northward with rain, and return to the south, in one or two days more, two or three times together, after this sort, then it is likely to be in the south or southwest, two or three months together, as it was in the north before.

Fair weather for a week, with a southern wind, will produce a great drought, if there has been much rain out of the south before. The wind usually turns from north to south, with a quiet wind without rain, but returns to the north with a strong wind and rain. The strongest winds are when it turns from south, to north, by west.

Clouds. In summer or harvest, when the wind has been south two or three days, and it grows very hot, and you see clouds rise with great white tops like towers, as if one were upon the top of another, and joined together with black on the nether side, there will be thunder and rain suddenly.*

If two such clouds arise, one on either hand, it is time to make haste to shelter.

If you see a cloud rise against the wind or side wind, when that cloud comes up to you, the wind will blow the same way that the cloud came. And the same rule holds of a clear place, when all the sky is equally thick, except one clear edge.

Sudden rains never last long: but when the air grows thick by degrees, and the sun, moon, and stars shine dimmer and dimmer, then it is likely to rain six hours usually.

If it begin to rain from the south, with a high wind for two or three hours, and the wind falls, but the rain continues, it is likely to rain twelve hours or more, and does usually rain till a strong north wind clears the air. These long rains seldom hold above twelve hours, or happen above once a year.

If it begin to rain an hour or two before sun rising, it is likely to be fair before noon, and so continue that day: but if the rain begin an hour or two after sun rising, it

* This is the formation of cumulostratus.

is likely to rain all that day, except the rainbow be seen before it rains.

If the last eighteen days of February and ten days of March be for the most part rainy, then the spring and summer quarters will probably be so too: and I never knew a great drought but it entered in that season.

If the latter end of October and beginning of November be for the most part warm and rainy, then January and February are likely to be frosty and cold, except after a very dry summer.

If October and November be snow and frost, then January and February are likely to be open and mild.

His omnibus ex ingenio suo quisque demat vel addat fidem.

CHAPTER V.

OF THE INFLUENCE OF PECULIARITIES OF WEATHER ON THE FUNCTIONS OF ORGANISED BODIES.

It is generally believed that atmospheric changes have considerable influence on the state of our health; and such a belief appears to be founded on reason: for, if a number of persons, of various ages, of dissimilar constitutions and habits of life, and at different places, become the subjects of disorder at the same time, which appears often to be the case, it is rational to attribute their malady to some general cause then prevailing. And the occurrence of disorder in particular kinds of weather, or at stated seasons of the year, which some persons experience, naturally suggests the idea that such cause resides in the air.

But it appears to me, that it is not the heat or cold, dampness or drought of the air, which is chiefly, concerned in

producing disorders, nor the sudden transition from one to another of those states; but that it is some inexplicable peculiarity in its electric state. The pain felt in limbs which have been formerly broken, previous to a change of weather, and the disturbed state of the stomachs of many persons before and during thunderstorms, are sufficient, I think, to warrant such a conjecture.

During what has been denominated unhealthy weather, when medical practitioners have spoken of the general ill health of their patients, I have remarked circumstances which appeared to denote an irregular distribution of the atmospheric electricity. The manner of the distribution, and the continual and multiform changes of the cirrus cloud, ramifying about and extending its fibres in every direction; the rapid formation and subsidence of the cirrocumulus and cirrostratus in different places, and the irregular appearance of the other modifications; the intermitted action of De Luc's aerial electroscope; strong and varying winds; and the abundance of luminous meteors by night; are the circumstances to

which I allude. A kind of weather too which appears to be remarkably unwholesome is characterised by all the clouds having confused indefinite edges.*

* In people of what are called nervous and susceptible constitutions, I have frequently noticed a remarkable variety in the appearance of the hairs on the head: they have appeared, at times, diminished in quantity: at others, superabundant. I have examined them carefully, in each of their states, and found their apparent diminution to consist in the shafts themselves becoming smaller, dryer, losing their tension, and lying in closer contact. I was once inclined to attribute their closer contact to a diminution of their electricity, by which they would become less mutually repulsive: this, however, does not seem sufficient to account for their decrease in size. The shaft may possibly be organized throughout, and its enlargement may be caused by an increased action of its vessels; there may also be an aëriform perspiration into its cavity, on an increase of which it may be more distended: and the increased size and tension of the shaft may result from the co-operation of these two causes. The increased size, strength, and tension of the hair, appear to accompany health, while the opposite state seems to be connected with disorder. The sympathies between the skin and the stomach have been frequently adverted to by physiologists; the skin has been found to be alternately dry and hot, moist and hot, dry and cold, and moist and cold; and these varieties have been attributed to varieties in a state of the stomach, between which and the skin a very direct sympathy is believed to exist. But the varieties in the appearance of the hair

But though we admit the influence of atmospheric peculiarities on our health, yet the manner and extent of their operation cannot easily be ascertained. They may deprive persons, already weak, of a portion of their electricity, and thus the energies of the brain and nervous system may be diminished: or the atmospheric electricity, being unequally distributed in the air,

do not appear to have been noticed. I have observed, that small doses of mercury have changed the appearance of the hair very soon after their administration. From being flaccid, dry, and small, it has become tense, strong, and moister. Now mercury may increase an aëriform perspiration into the cavity of the shaft, if such an one exist; it may also rectify a disordered state of the digestive organs, and, by that means, cause a stronger and more healthy action of the vascular system, and of the vessels of the hair among the rest. I think it by no means follows that hairs are not vascular, because we cannot demonstrate their vessels. On this subject, I think, we may reason thus: if all nourishment be effected by the action of vessels, it follows, either that there must be some vessels not nourished at all, or that vascularity must extend ad infinitum. Can we demonstrate those small arteries which ramify in the coats of, and nourish the smallest vasa vasorum? Such reflections as these ought to prevent our denying organization to any part of a living body, even to the cuticle or the enamel of the teeth.

or propagated downward at intervals, it may occasion an irregular distribution of it in our bodies, and produce an irregularity of function. A living animal consists, as to its vital parts, of numerous nerves, which give life, as it seems, to all the parts, and compose different organs of vitality and mind, but these must have some mover. We do not know that this moving principle is electricity; but it seems reasonable to ascribe it to something in the air; because, deprived of good air, we soon die. It would be vain to inquire into the principle of life; but as air is necessary to its continuance, so bad injures it: so to some peculiarity in its quality we can reasonably ascribe as many unknown disorders, even were there not remarkable appearances in the atmosphere at the time of their prevalence. In whatever way the nervous functions may be disturbed, a disordered action of the digestive organs will be the probable consequence; and a state of nervous and digestive disorder being once induced, other diseases may insue, to which there may be a constitutional predisposition.*

* This part of the subject has been well illustrated by Mr. Abernethy, in his "Surgical Observations

But it would seem that there were a more immediate connexion between the peculiar state of the air, and the kind of disorders which might be thereby excited, than this. For it may be observed, that even of those disorders which are not generally admitted to be contagious, one particular kind will prevail for a long time. Thus, in winter, the different symptoms of that state of body which we call a cold, appear, in some measure, to prevail and vary together; so that it is common to hear people talking of the fashionable complaint. Coughs, for a while, are the prevailing symtoms; then sore throats are the most common. It is in spring that certain kinds of cutaneous eruptions usually appear; and in autumn, that those irregularities in the functions of the digestive viscera, called cholera morbus, etc. happen, besides the many diseases that in tropical climates accompany particular winds or weather. It is possible there may be different states of atmosphere, which act as specific stimuli, and produce their corresponding peculiar diseased nervous actions,

" on the constitutional Origin and Treatment of Local
" Diseases."—London, 1813.

having as it were a joint cause, and being further varied by the particular state of constitution, and other circumstances of the patient.

Even contagious diseases break out at very uncertain periods, and often without any obvious cause, though they are afterwards evidently propagated by infection. Parts of Turkey are said to be visited by the plague every five or six years, while the same disorder appears more rarely in other places. The small pox rages for a time throughout whole tracts of country; at others, there is scarcely a case to be met with: the same may be observed of scarlitina and measles. I cannot persuade myself that this is merely the effect of accidental introduction. Is it possible there may be some quality in the air, at particular times, whereby it is fitter for the conveyance of infectious matter? Or, can we suppose the effect of a peculiar state of atmosphere to be that of rendering the body more susceptible of infection than ordinary.

In artificial society there are so many causes operating to produce ill health, that the extent of the influence of any one can

hardly be ascertained. Inactive habits of life, bad air, irritating food, the drinking of spirituous and fermented liquors, the misguidance of the appetites, and the reciprocal operation of the mind and body on each other, have all a tendency to produce disease. But though these various evil habits of artificial life all act to our detriment, their kind of influence may be somewhat different: and in proportion as families, and even nations,* may have indulged, from time to

* In the production of national varieties, local situation is probably much concerned; and, in this case, the influence of the atmosphere, in their production, does not seem to depend on the degree of heat alone: for not only the colour of the skin and hair, but the form and countenance, and also the diseases of different nations inhabiting nearly the same latitude, vary considerably. The varieties of the soil and its vegetable productions, which constitute part of their food, may have a degree of influence; and so may peculiarities in the electric state of the air in different longitudes: but there are hordes of savages inhabiting the same tract of country, and living in near neighbourhood, which differ much from each other. And we may add, that among people of the same nation there are scarcely two heads and consequently no two minds exactly alike. It is remarkable, that this variety of figure, of expression of countenance, and apparantly of kind of mind, is increased in proportion as man becomes civilized. The number

time, in any of them, they may have acquired what are called constitutional pecu-

and variety of his diseases are also multiplied by civilization. The effect of civilization in producing variety and disease, is also observable in those animals which have been domesticated. In proportion as they have approached the habitations of man, and lived under his roof and protection, their natural habits have become altered and perverted, the size and figure of their bodies changed and various; and they have, like man, to whom they owe their deformity, become the subjects of numberless diseases. I have dissected many domestic animals, and have often found in them extensive ossifications of soft parts, and preternatural tumours: but I never recollect to have found any marks of organic disease in those which may be truly called wild.

Human nature, from the influence of various causes, having been infinitely varied, and constitutional varieties being in some measure transcendant, every one is probably born with some peculiarity, and, perhaps, more or less, with some particular tendency to disease. Peculiarities of character being afterwards modified and diversified by education, the varieties become almost infinite. The subject of variety leads me to the following considerations. Of all the animated and vegetable beings which inhabit the earth, no two species are alike, each has its peculiarities. From the concretions of the earth itself, up to man, there appears to be a succession, to use common language, of more and more perfect beings. From saxeous excrescences we ascend to lichens, and, through all the infinitely various tribes of vegetables, to the polypus and star fish, connecting, as it would seem,

liarities or temperaments; and the diseases dependent on them may be infinitely varied by the subsequent combination of different evil habits in individuals. For example, sedentary occupations have been considered to hurt our health, by causing an accumulation, or irregular direction, of the nervous energy, which ought naturally to be spent on the various muscles. Thus patients, suffering great and peculiar nervous irritation, have been relieved by a degree of exercise, which, in common cases, would have caused lassitude. The different kinds of spirituous

vegetable and animal life together. From these every link in the chain appears filled up by numberless animals possessing intellect in different degrees, and having infinite peculiarities, till we arrive at man. And in man what infinite variety of organization in different individuals both in kind and degree, from the most complete ideot, whose abject imbecility brings him below the level of a brute, to the most elevated and intellectual character. In ascending the scale of mind, and tracing variety through all its branches, whether we consider that difference which merely arises from the comparative developement of different organs, or that which is produced by all the numberless disorders of body, or by mental insanity, do we ever observe two alike?—All nature is chequered with endless variety of forms, which appear from time to time and are lost for ever, while mutability goes on producing ceaseless combinations.

and fermented liquors are, probably, pernicious, by affording a stimulus exhausting to the strength; but whether they prove uniformly injurious in proportion to the quantity of pure spirit which they severally contain, or whether the different kinds of spirituous drinks cause different specific actions, is a point which, I think, has never been determined. Doctor Lambe considers animal food and impure water as exhausting stimuli; but he seems to think their respective actions on the system as somewhat different. If they do actually contain deleterious substances, the doctrine about which however seems very vague and inconclusive, their evil influence may be increased, in certain states of disease, by the lacteals losing their discriminating power, and, like common absorbents, drinking up unassimilated or noxious matter, in consequence of a disordered state of the chylopoietic system. In these cases, then, attention to regimen must be particularly necessary. Such a view of the subject as this enables us, in some measure, to reconcile the beneficial effects of vegetable diet on many persons, with the apparent health of others who live chiefly

on flesh. To return from the digression into which I have unavoidably been led: those persons are most likely to be disordered by atmospheric peculiarities, who have the greatest susceptibility of constitution, and, at the same time, the greatest weakness.*

* It appears, that an unhealthy quality in the air, which was believed to excite disorder, was frequently alluded to by ancient writers. So Lucretius—

Nunc ratio quae sit morbis, aut unde repente
Mortiferam possit cladem conflare coorta
Morbida vis hominum generi, pecudumque catervis,
Expediam. Primum multarum semina rerum
Esse supra docui, quae sint vitalia nobis;
Et contra quae sint morbo mortique, necesse est
Multa volare; ea quom casu sunt forte coorta
Et perturbarunt coelum, fit morbidus aër.
Atque ea vis omnis morborum, pestilitasque
Aut extrinsecus ut nubes nubulaeque superne
Per coelum veniunt, aut ipsa saepe coorta
De terra surgunt ubi putrorem humida nacta est
Intempestivis pluviis, et solibus icta.

Lucret. de Rer. Nat. lib. vi. 1089.

Again—

Est elephas morbus qui propter flumina Nili
Gignitur Aegypto in media, neque praeterea usquam.
Atthide tentantur gressus oculique in Achaeis
Finibus: inde aliis alius locus est inimicus
Partibus ac membris; varius concinnat id aër.

De Rer. Nat. lib. vi. 1112.

SECTION I.

Further Observations on the Effects of Atmospheric Peculiarities on the Functions of Organized Bodies.

Every organized body, as far as human sagacity can penetrate, appears susceptible of diseased actions, which may be excited by different causes. In man these causes are various and complicated, and the morbid actions which arise, in consequence, are numerous and dissimilar. And this circumstance may be attributed to his organization and to his mode of life. The influence of the atmosphere, which is one cause, is apt to be overlooked in the human subject, from the variety of others which are continually

Which Virgil has imitated—

Hic quondam morbo coeli miseranda coorta est
Tempestas, totoque Autumni incanduit aestu.
Et genus omne neci pecudum dedit, omne ferarum,
Conripuitque lacus; infecit pabula tabo.
Virg. Georg. lib. iii. 478.

operating, and which, though by their conjoint influence, they predispose to, and often aggravate its effects, have nevertheless a tendency to mislead our judgment as to the manner and extent of its operation.

Animals, particularly those which are domesticated, on which alone we can make any accurate observations, have many sources of disorder, though not so many as man has. They may suffer from hunger, from unnatural food, from fatigue, or from accidental injury, which may produce disease, and which may be the cause of their becoming affected by peculiarities in the air: notwithstanding their comparative freedom from the evils of intoxication, gluttony, and mental perturbation, that prove so frequently destructive to the human subject. The almost simultaneous occurrence of canine hydrophobia in distant parts of the country must be ascribed partly to some peculiarity in the atmosphere; while the circumstance of its occurring primarily only in a few dogs, would lead us to consider some pre-existing, and, perhaps, unnoticed state of disorder in the animal, as conducive to the

more violent affection subsequently excited by the air.* There are many other instances on record of epidemic distempers among animals, which have prevailed only for a time, and which seem to be referrible to the atmosphere. A few years ago, in Essex, a mortality prevailed among cats, which carried off considerable numbers. The mange is said to be contagious; but, if this be the case, it is one of those disorders which arises from unknown causes in a great many animals at once, and may be afterwards propagated by contagion. The same mode of reasoning seems applicable to the glanders of horses, and to many other distempers of cattle.

How far electricity may be concerned in all this, it is difficult at present to say; but

* Virgil aptly alludes to the influence of unhealthy air on animals, though not subject to the general causes of human diseases, namely, wine, gluttony, and mental anxiety.

—— Atqui non Massica Bacchi
Munera non illis epulae nocuere repostae,
Frondibus et victu pascuntur simplicis herbae
Pocula sunt fontes liquidi atque exercita cursu
Flumina, nec somnos abrumpit cura salubres.
Virg. Georg. lib. iii. 530.

the discoveries which philosophers are daily making, relative to the extensive operation of this fluid, (for such I must call it, till a better name be found,) seem to encourage a suspicion, that its agency is concerned in producing every change in the universe.

SECTION II.

Of the Effects produced by Peculiarities of Atmosphere on Vegetables.

NOT only the animal, but also the vegetable kingdom, appears to be affected by peculiarities of the atmosphere, which do not consist in its degree of temperature or pressure. For example, in the summer of 1810, almost all the plane trees, with the rough bark or rind,* became diseased in the neighbourhood of London, and for many miles round; very few of which, in comparison with the whole number decayed, recovered so far as to throw forth buds the ensuing spring, while the smooth rined plane trees † and sycamore trees ‡ remained

* Platanus Occidentalis. † Platanus Orientalis.
‡ Acer Pseudoplatanus.

healthy. The season was not either remarkably hot nor very unusually dry; but there were all those circumstances alluded to in a preceding section as demonstrating an unusual state of the atmospheric electricity. The succeeding summer, that is, in 1811, some of the same species of plane trees were again deceased, and a few died. I am informed, that some years ago a similar, though not so extensive a mortality, prevailed among the smooth rined plane trees. From hence it would appear, that there were particular states of atmosphere which become specific stimuli to diseased actions of particular plants. Abundant proof of the fact, that particular seasons destroy particular tribes of vegetables, may be collected from gardeners and nurserymen. There are many other facts, which it would be useless to detail, that illustrate the proposition, that there are other peculiarities of atmosphere, besides heat, cold, damp, &c. which affect the functions of organized bodies.*

* It cannot, I think, be considered, that atmospheric peculiarities alone produce epidemic and other complaints, which must be regarded as having a compound origin, and as resulting from the operation of peculiar

states of atmosphere on persons of particular states of constitution; otherwise, all persons would be affected, which is contrary to experience. There are, probably, innumerable varieties of temperament, of general habits of life, and of preexisting diseases, which, in different subjects, vary the effects of the air. And many persons, perhaps, enjoy a state of health, and perfect action, which may be capable of resisting its evil influence altogether. It would, perhaps, be productive of useful results, if physicians of extensive practice would make accurate meteorological registers, during the prevalence of any epidemic or contagious disorders: such as the influenza, which, a few years ago, took a range for some miles round London, but was also prevalent in other parts of the country.

Since writing the above, I have met with some curious observations on the influence of climates, (which correspond, in some measure, with what I have advanced,) in a French work entitled *Rapports du Physique et du Moral de l'Homme, par P. J. G. Cabanis*, 2d edit. Paris, 1805.

CHAPTER VI.

SOME PARTICULARS CONCERNING WINDS.

WIND has been explained in the following manner. Heated air has a tendency to rise, and cold air rushes in to supply its place. Thus the heated air of the equatorial regions rises, and gives place to a current from the polar regions, which is a process that serves to equalize the temperature of the world. But the polar countries lying nearer to the axis of the sphere, the air from those regions has not received so much motion as that about the equator, or greatest distance from the axis; wherefore it arrives at the equator, where the motion of the earth is greater. If it had no motion before, an East wind would be the consequence, and the force of that wind would be as the difference between the motion of the earth where the air came from, and that where it arrived: but then it has a motion to the South; for it is rushing into a vacuum, left by the air which

rises: so that the wind will not be from East, but North East; and the number of degrees North of the East from which it will blow will depend upon the comparative force of the current of air from the North to the difference between the earth's motion at the equator and at the polar region, from whence the air comes. As there must be a corresponding efflux from the equator higher up; according to this theory, the wind should every where be North East or South West; but it blows in very different directions at different times and places; and this probably depends on the variations in temperature at different times and places. I shall not enter into the detail of the subject, but refer to several treatises written on winds by different authors.*

I have lately remarked a circumstance with regard to the change of winds, which I have never heard mentioned by meteoro-

* Since the publication of the first edition of this work, I have made many experiments with balloons, and have observed them always to move in two or more currents, whenever the wind was not so great as to carry them soon away from sight.

logists, and which may therefore be worth noticing. I have observed, that when the current next the earth has changed its direction, it has frequently got into a quarter from which an upper current had previously blown. I was first apprized of this, by observing the motion of an upper stratum of clouds to be different from that of those which were lower; and by the lower clouds afterwards taking the direction of those above: but as I had few opportunities of observing this circumstance, I thought it merely accidental. Subsequent observations on the various directions of air balloons, and the succeeding changes of the wind, have convinced me that it is frequently the case, that the changes of the winds begin above, and are propagated downwards. And I have observed this of several successive currents.

For a detail of some of my experiments made to ascertain this circumstance, I refer the reader to the Appendix to this volume.

CHAPTER VII.

OF ELECTRICITY.

If we look back into the history of any branch of science, we shall observe, that in the progress of its developement, men have, from time to time, introduced a number of different hypotheses to explain the causes of the complicated phaenomena which they observed; which hypotheses have obtained credit for a while, and have reigned triumphant; but before long they have faded away, from being found incapable of explaining more recently discovered facts, or have been overthrown by others of greater pretensions to credit. From time immemorial, systems of philosophy have mutually overthrown and succeeded each other; and many, which have been rejected by philosophers of antiquity, have been brought into vogue again, under some new dress, by subsequent generations: and thus, in the revolutions of science, systems have alternately decayed and flourished at remote distances

of time. Electricity affords a striking example of this. After the two different electric states of bodies, commonly called the positive and the negative charge, were discovered by certain dissimilarity in their effects,* philosophers began to dispute about the state of those bodies. Some contending that when two different electrics were rubbed together, so as to become electrified, the one gained as much as the other lost of a fluid matter, which they called the electric fluid; and that when, by subsequent approximation, or the intervention of conductors, their electric properties ceased, an equilibrium of the fluid in the two bodies was again restored. While others contended for two distinct fluids, which had a sort of attraction for each other. Upon this supposition, the electrification of two different bodies by friction was a separation of the two fluids, one to each electric, and the equalization was a commixture again, or a distribution of both electricities through both the electrics. Many

* For example, the difference of appearance of the luminous star on the point of a conductor, when applied to a body positively charged, from that of the star on the point directed to one negatively charged.

plausible experiments and arguments were used in favour of each hypothesis: but the former always obtained the most credit. While electricians were thus contending, the ingenious I. A. De Luc proposed a system somewhat different from either of the former, an account of which may be found in his works, to which I refer the reader, and leave him to judge of the validity of it by the evidence there adduced. While some philosophers have contended for one fluid, and some for two, others have recently contended for no fluid at all, and have spoken of electrical effects as depending on the agencies of matter. Without dwelling on these adverse systems, which appear, in a great measure, verbal differences, I shall merely observe, that there are certain modes of action of bodies on each other, such as all the phaenomena of artificial electricity, etc. which custom has ascribed to the agency of a specific fluid. Whatever may be the principle of their action, the daily experience of philosophers shows the extent of this principle. Indeed, recent discoveries and experiments incline one to regard it as the universal agent in all the changes of

form which matter undergoes.* A notion of the antiquity of which, though it be now newly revived as a subject of philosophical speculation, there appears some traces of in the accounts left of the religion of Zoroaster, or the worship of the spirit of fire, as the soul of the universe, the source of all motion and of life.

In attributing the forms of clouds, the production of rain, and other atmospheric phaenomena, to electricity, I would not be understood to involve any particular theory of the mode of electrical action. It is merely intended to ascribe similar appearances to similar causes, and to extend the principle of action upon which the phaenomena of artificial electricity are explained, which has been identified with that of lightning, to other atmospheric productions, which, at first sight, are less obviously referrible to similar agencies.

I have already, in treating of Mr. Howard's theory of the modifications, shown how reconcileable that theory was

* The discoveries made by Sir H. Davy seem calculated to throw light on this interesting subject.

to the various phaenomena exhibited by the clouds. There are many things, however, which I have not sufficiently explained there, which may be mentioned in this place.

SECTION I.

Of the Electric State of the Modifications of Clouds.

It is necessary to the present hypothesis, and is indeed conformable to constant experience, to consider lightning, at least one kind of it, to be the discharge of the electric spark; and yet, at first view, the reconciling the electric charge of the nimbus, which would be necessary to the effect, with its being the result of the union of two dissimilarly electrified clouds, and consequent neutralization of the two electricities, seems to involve a contradiction. To explain this, I must observe, that after two differently electrified clouds, whose structure and buoyance depended on the similar electric charge of their particles severally, by a communication, and the in-

tense union of the said particles, should form the dense structure of the nimbus, the latter cloud, when formed, may acquire a strong charge, for it would be thrown into an opposite state to that of the earth, or other objects over which it might pass, or to other clouds in vicinity; for its acquiring again a charge would not cause it to reassume the primitive structure of the clouds of which it was formed, for it now was condensed to minute drops of water, a state probably very different from that of any other modification. Under these circumstances, then, the nimbus may exist as a highly electrified conductor: and it is probable that the difference between common showers and thunderstorms consists in the intensity of the charge which the nimbus acquires after its formation.

It must be granted, that though the present theory seems so well to agree with the formation of nimbi, it is nevertheless insufficient to account for all the differences of the other modifications. We may readily conceive the fibrous structure, and other circumstances of the cirrus, to be the effect of its office as a conducting body, effecting

an electric communication; but we can assign no reason why a strong positive charge should produce a cirrocumulus, instead of a collected mass like the cumulus, nor under what dissimilar circumstances electricity should cause the infinite variety of forms under which that cloud, or the cirrus or cirrostratus, appear on different occasions. It has been conjectured, that the plane cirrostratus is often placed between two differently electrified plates of air, between which it may be effecting a slow communication; and that the alternate bars of this cloud, at other times, may be interposed between portions of air alternately electrified with plus and minus. Experiments are wanting to ascertain these facts; but, could they be demonstrated, such an alternate distribution of the electricity of the air would remain unaccounted for. If the conjecture be true, the streaks of cirrostratus may serve an office analogous to that of the water interposed between the plates of zinc and copper in the voltaic apparatus: and it is a fact, in some measure conformable to this idea, that the cirrostratus, after losing its wavy or its striated ap-

pearances, has been observed to condense into a nimbus, and produce rain without the help of any other cloud, as if it contained within itself the principles of its own resolution into water. The oblique and curved columns of this cloud seem, indeed, hardly explainable even on this supposition. The curious cymoid feature, which so often precedes storms, is not merely alternate bars, but the bars are curiously curved; a circumstance still more difficult of explanation. Future and repeated observations may, possibly, in the course of time, throw more light on these varieties.

To return to the cirrocumulus: if it be a cloud with a strong charge, and very retentive of it, the latter circumstance, probably, results from its being surrounded by dry air, which is not a conductor. Conformably to this view, I have noticed the loose indefinite features, which accompany damp air, and appear, in the intervals of common showers, to be of short duration: and that they have passed to a sort of confused cirrus or cirrostratus, while the dense and compact aggregates, which compose the stormy features, are often of long dura-

tion; and I have not observed this dense feature to form itself into cirrus and cirrostratus in the manner afore described. The densest nimbi, and the hardest thunderstorms, often follow its conjunction with cumulus and cumulostratus. Another distinction is also worthy of remark. The loose, flimsy, and transient features of cirrocumulus, often appear above, when cumuli are rapidly flying along in the gale below; whereas the denser feature more often accompanies a calmer air, particularly the dead calm which precedes a storm on a sultry summer's afternoon. There are other kinds of cirrocumulus, as I have already mentioned, which attend fine warm weather, which are large distinct and well defined aggregates arranged all over the welkin. To me it is somewhat doubtful what particular kind of cloud Virgil,* Lucretius,† and Pliny,‡

* Tenuia nec lanae per coelum vellera ferri.

Virg. Geor.

I must refer the reader to my edition of the Diosemeia of Aratus.

† Concipiunt etiam multum quoque saepe marinum
Humorem, veluti pendentia vellera lanae
Quum supera magnum venti mare nubila portant.

Lucret. vi. 504.

‡ Plin. Hist. Nat. xviii. 35.

alluded to as being like fleeces of wool, and which accompanied rainy weather. The descriptions of them by the Roman poets seem to have been imitated from Aratus, in his Diosemeia, who represents them as signs of rain.*

SECTION II.

Of the Electricity of Thunder Clouds; and of Lightning.

IT has appeared by some experiments, that a thunder cloud exercises its electrical influence on the surrounding air, and throws it into an opposite state: so that if the cloud be positively electrified, there is a portion of air negatively electrified around it; and, beyond that, a positively electrified portion perhaps again. But a sufficient number of experiments have not as yet been made, with electrometers, to certify whether this be the case with all

* Πολλακι δ' ἐρχομένων ὑετῶν νέφεα προτάροιθεν,
Οἷα μαλλιστα πόκοισιν ἐοικότα ἰνδάλλονται.
Arat. Dios. 207.

clouds. It is probable most of the flashes of lightning never reach the ground, but are only communications between the thunder cloud and some other, either oppositely, or not at all electrified.

The hypothesis of Van Mons, that the two different kinds of thunder and lightning are the result of very dissimilar causes, and that one is the combustion of the gasses of water, seems wanting in proof. The reports are certainly different; and mischievous effects generally happen with that kind of which the report is single, or of very short duration, and which happens soon after the flash. But these circumstances may be attributed to the nearness of the cloud to the object destroyed by the lightning. There are, however, differences in the appearance of lightning: it looks at some times much brighter, and of a bluer light, than at others. This difference of colour is most remarkable in the vespertine fulgurations in summer; which form the subject of the next section.

I cannot omit to mention one circumstance, which seems rather contrary to my explanation of the differences of claps of

thunder, and rather favours the hypothesis of M. Van Mons, namely, that the two kinds of thunder often happen, and, indeed, alternate with each other in the same storm.

The meteors or balls of fire which occasionally shoot from thunder clouds during a tempest are very curious; they seem to show, if they be electrical, which is most probable, that similar causes to those which produce thunder and lightning may also produce the electrical fire embodied in the form of meteors. A curious experiment to show the embodied form of the electric fluid was made in France by MM. Arden and Constable. Refer to Bertholon Elec. Met. vol. ii. p. 27.

SECTION III.

Of Silent Lightning.

THE silent lightning of warm summer evenings seems sometimes to come from visible clouds; but, at others, flashes of great latitude appear almost all around the horizon, when no cloud can be seen. These are

either the effect of clouds too distant to be observed, or they may be communications between the damp earth and the hazy air above. The most remarkable thing, is their always being seen in the horizon. When there be definite clouds about, then are the flashes the brighest; a circumstance which looks as if the flashes which appear without clouds were only at too great a distance for the clouds from which the flashes come to be seen. In either case the communication may often be with the ground, which, in the damp of the evening, with falling dew, would not be violent, as the general moisture would afford a more free and latent, and, consequently, a more gentle passage to or from the earth.* Upon this principle, we may see also why nocturnal storms are generally less mischievous than those which happen in the day time, and why there is additional security in thunder-storms after the rain has commenced.

* The Abbé Bertholon thought he could determine when the lightning rose from the ground to the cloud, and when it descended from the cloud to the ground. *Bertholon*, Elec. Met. vol. i. c. iv. p. 132. He refers to a letter of Maffei, *Della Formazione del Fulmine*, in the *Journal de Venice*. Tom. xxxii. art. 7.

SECTION IV.

*Of the Aurora Borealis.**

AFTER the attention of philosophers began to be directed to the atmospheric electricity, the Aurora Borealis and Australis, commonly called the Northern Lights, were considered as electrical. There appear, however, to have been several different explanations of this phaenomenon.

Franklin regarded the coruscations of northern lights as the result of a slow and continual discharge of electric fluid from the atmosphere about the poles to the air above; and Sir H. Davy, and also many other electricians, have noticed the striking similarity between those lights, and electricity discharged through rare air.†—The reason why these Auroras only happen towards the poles, has been said to be, because in high latitudes alone there can be a continual coating of ice and snow, to prevent the electric com-

* *Aurora Polaris* would be a better name; as it is not confined to the Septentrional regions.

† Refer to Davy. Elem. Chem. Philos. vol. i. p. 141.

munication taking place between the earth and the atmosphere above. The Aurora has also been explained by supposition that the earth may have electric polarity; and the correspondence between the centre of the Aurora and the magnetic poles, which has been asserted, is a circumstance very worthy of future consideration, as it tends to establish more certainly the connexion between electricity and magnetism.*

* Mairan, in his Traité Physique et Historique de l'Aurore Boreale, 4to. Par. 1754, observes that it resembles what is called the zodiacal light; and supposes that they are both emanations from the sun. In the work above alluded to, many curious accounts and figures of the Aurora, may be found. For further accounts, consult Phil. Trans. Also Bertholon Elec. Met. vol. ii. p. 49.

Since the publication of the first edition of this book, the phaenomenon of the Aurora Borealis has again attracted the notice of meteorologists in this country; but they have neither been so grand, nor so frequent as formerly.

SECTION V.

Of several other Electrical Phaenomona.

To the above described electrical phaenomena may be added several other dissimilar appearances, referrible to the same principle, operating under different circumstances. Water spouts probably result from the attraction of a nimbus for the water over which it may be, whence both are violently drawn towards each other, till they meet:* and when the electricity of the cloud has been equalized with that of the water, the column comes down. Though this effect is, to a certain degree, explainable on this supposition; yet, as, in other instances, the particular circumstances under which this rare phaenomenon takes place, are as yet obscure.

Cavallo attributed the fiery meteors described in another place to electricity. As I

* A friend of mine calls this contact of the waters from below with those from above, Neptune shaking hands with Jove.

have already spoken of these phaenomena; it is unnecessary to add much more. I only observe, that there is this difference between meteors and electric communications, that the former occupy some time in their passage, whereas electric communications are instantaneous; that is, they take place in no perceivable time.*

The variety too in the colour of the light of meteors, their scintillations, and the prismatic colours sometimes observed in the tails of the larger sort, are circumstances which do not appear to me analogous to any known electrical phaenomena.

Dr. Blagden, in the *Phil. Trans.*† observes, in proof of the number of blue rays which entered into the composition of the light of the great meteor of 1783, that the moon appeared at Brussels quite red, during

* There is this difference in the motion of the brilliant and larger kind of falling stars or meteors, and the other two kinds, which I have called the stellar and the caudate. The brilliant meteors of summer evenings have sometimes a curvilinear motion; whereas the other two sorts always move nearly straight: though as far as I can observe, with different inclinations to the horizon, on different occasions.

† Phil. Trans. lxxiv. 208.

the meteor's passage, from the contrast of light.* I have noticed this reddish appearance of the moon during the combustion of many substances which burn blue, in pyrotechnical exhibitions. In the tail, and in the separated scintillations of the aforesaid great meteor, prismatic colours were observed very variously, by persons in different places.

These appearances seem certainly to favour the hypothesis of M. De Luc, as I have before observed, rather than any mode of explaining them on the known laws of electricity.† During thunderstorms however meteors occasionally come down like balls of fire which sometimes seem very like those described above.

There are several dissimilar appearances,

* Dr. B. refers to a letter of Abbé Mann to Sir Joseph Banks.

† Some have considered shooting stars as bodies projected from the moon, and ignited in their course. In this case, the peculiarities of their light, at different times, might be caused either by the quality of the air in which they burned or by the quality of the ignited body. Meteorolites too have been considered as similarly projected from the moon, and have thence received the appellation of Lunar Stones. And this opinion has gained support by their analysis, which does not correspond with that of any known terrestrial compound.

which may be mentioned in this place, as

Biot, in his Astronomie Physique, and La Place, in his Sys. du Monde, seem rather of this opinion.[c] The altitude of what are called falling stars, above the earth's surface, has never been well ascertained, though it might easily be done by geometrical observation; at least, in many cases, where the meteor could be identified, as seen in different places. They are not seen below clouds; and, indeed, none, except the larger and brilliant kind, are usually observed when there are many clouds about: but this may arise from the state of the atmosphere necessary to their production being incompatible with the existence of much cloud. M. De Luc mentioned to me his having seen them from the top of high mountains, and that they then appeared at a very great distance. From observations which I have made, they certainly vary in the height, as well as the length, of their course. It is not impossible, but that if meteorolites were observed to fall at night, they might be always found to be accompanied by some fiery phaenomenon of this kind. The almost horizontal motion of some large meteors, would be no objection to this hypothesis, if they always moved from E. to W. or nearly so; as, when they came into the sphere of the earth's attraction, their motion might be spent, and they would then receive an apparent motion compounded of the opposite of the earth's rotatory motion, and the attraction to the centre. An analysis of several meteoric stones may be found in Sowerby's Brit. Mineral. vol. ii. p. 18. A catalogue of many of them, and of the places where they fell, was made and published in France; there are also many accounts of them in several numbers of the Philosophical Magazine.

subjects worthy of the future investigation of natural philosophers, which seem referrible to electricity: and which appear to hold a middle nature between the igneous meteors above described, and known electrical phaenomena. There are, occasionally, stationary meteors, simple accensions, which appear in cloudy skies, and last scarcely a moment. There are also luminous portions of clouds occasionally, of less intensity of light, which are faint and glimmering, like luminous nebulae: and others, which have a rapid motion, that may be said to have the same relation to moving meteors above, which the pale light about plants, before noticed, bears to the well known phaenomenon which occurs below called the Ignis Fatuus, Jack with a Lantern, or Will with a Wisp.

SECTION VI.

Of the Electricity of the Air.

WHAT has hitherto been said of the electricity of the atmosphere, related chiefly to

that of clouds. In serene weather, however, and in the absence of all clouds, the air has shown signs of being electrified, by means of kites raised in the air, and other electrometers.* That air should, at different times and places, have positive and negative charges, is not at all surprising; but the circumstances under which such charges have taken place do not appear to have been sufficiently attended to.

During very clear weather, the air has generally been found to have a positive electricity, and the exceptions to this rule have generally happened when either a strong wind has blown, or when there have been clouds in the vicinity of the electrometer. That large electrified clouds throw the surrounding air into an opposite state, has already been stated; and some circumstances have induced an opinion, that there are alternate portions of air with different electricities round the electrified clouds. And it becomes a question for future solution, whether, when air is found electrified positively, there is not

* See Becaria Elec.; also Cavallo Comp. Treat. Elec. Letters of Abbé Nollet, in Phil. Trans. etc.

a counter charge somewhere else? Possibly the whole atmosphere, and the earth too, may have electric polarity. That the electric state of the atmosphere varies much at different times, is beyond a question, from the facts above stated; but the causes of its irregularities, which, in fact, involves the causes of clouds, etc. is as yet a mystery. There have been found alternations in the electric state of the atmosphere, that is, rapid changes from a positive to a negative state, and vice versa. These circumstances were observed near the Appennines, when a strong wind blew, and when clouds hung about the tops of those mountains, described as having rectilinear spouts at the top, and which, from the description, I take to be a kind of cirrus.* Other clouds appeared at the time, which, by the account, appear to have been dense cumulostrati and cumuli. As irregularities in the electric state of the

* Clouds of this kind, attaching themselves to the tops of high hills and mountains are noticed by Saussure as being called les nuages parasites; and considered as portending rain. Refer to Saussure, Voyage dans les Alpes, §. 2070, and M. Du Carla in Journal de Physique for 1784. Homer. Iliad. v. 522. Theophrastus, De. Sign. Temp., and Aratus, Dios. 188.

air may be concerned in the production of many disorders of health, the investigation of them becomes additionally interesting. It is much to be wished, that those who have opportunities of making experiments with electrical kites, &c. would attend to what is the general disposition of the clouds, which prevail during different states of the atmospheric electricity. An instrument likely to throw some light on this subject has been invented by M. De Luc, described in the next section.

SECTION VII.

*Of M. De Luc's Aërial Electroscope, and the Connexion observed between its Action and other Atmospheric Phaenomena.**

It may not be improper to present the reader with a short account of M. de Luc's Electric Column, or Aërial Electroscope, as this instrument has been frequently alluded to in my Journals.

* See Letters of M. De Luc on this column in many numbers of Phil. Journal, and in Phil. Mag. the present month, Oct. 1814. p. 248.

It is composed of a great number of small circular and very thin plates, about the diameter of a sixpenny piece of silver, of paper, and of zinc, alternately arranged, forming a column; the two ends of which are made to approximate, and at each of them is attached a small bell; a metallic clapper is then hung between them, and the whole apparatus is insulated by being fixed on glass stands. One end of the column is observed to become electrified *plus*, as it is termed, and the other *minus*; consequently, one of the bells becomes electrified *plus*, or positive, and the other *minus*, or negative; and the metallic clapper moving rapidly from one to the other, to equalize the two electricities, a pulsation is produced, and the bells ring. Neither the heat or cold, dryness or moisture of the atmosphere, appear to have any considerable influence on the action of this instrument; but it is considerably altered by peculiarities in the electric state of the atmosphere. The prevalence of cirri ramifying about the sky in various directions, and accompanied often by other modifications, by dry easterly and changeable winds, and by numerous small meteors of an evening,

which appear to indicate a disturbance in the atmospherical electricity, I have noticed to be accompanied by an irregular action of the Electric Column of M. De Luc; the bells ring at intervals, and with a kind of hurried pulsation. When such weather as I have described is followed by rain, the bells have been found silent. There are also other varieties in the kind of pulsation of the bells; sometimes they ring weak and regular, sometimes weak and irregular, sometimes strong and regular, at others strong but irregular; the intervals of quiescence are sometimes of longer duration than at others. These minute variations are probably connected with peculiarities in the state of the atmosphere, as I have said above, which are worthy attention, because they may be principally concerned in producing many disorders of health which are attributed to atmospheric influence: when the weather is settled, when only diurnal cumuli prevail with westerly winds, then the action of De Luc's column is the most regular; and this is found to be the most wholesome kind of weather.*

* See Phil. Mag. June and July, 1811. Since the

publication of the first edition, I have seen the superb columns made by M. De Luc, himself. The varieties of the action seem to correspond with my own observations on the instrument belonging to Mr. B. M. Forster, of Walthamstow, which continued ringing (with varied action) for a year, and which received the whimsical appellation of the perpetual motion.

CHAPTER VIII.

FURTHER INVESTIGATION OF PECULIARITIES OF WEATHER.

If it can be shown, as above, that there are varieties in the state of the atmosphere, with which the prevalence of disease seems conjoined, so that the said diseases may be referred to its agency, analogy would lead us to ascribe other diseases, for which no particular cause could be assigned, to some other peculiarity in the air, which, however, might not be demonstrable by any meteorological instruments; and our inquiries will be directed to discover in what such peculiarities may consist. I have already shown that the peculiarities of weather, alluded to as being accompanied by the great prevalence of disorders, do not appear to consist in the dampness, dryness, heat, cold, levity, or gravity of the atmosphere, nor in the combination of any two or more of these, or any other qualities of the air, demonstrable by meteorological instruments; but that, in

many instances, they appear to be marked by the peculiar character and distribution of the clouds, and the appearance of other meteors; the relation of which to the state of the thermometer, barometer, and hygrometer, have not been duly noted; that is to say, there has been no discoverable peculiarity in the state of those instruments at the time: but the actions of De Luc's aërial electroscope have been intermitted, or otherwise irregular and inconstant.

As the peculiarities of weather alluded to are characterised by difference in the distribution of the clouds in general, and of other meteors, and do not consist in the varieties of any one cloud in particular; and as the former part of this work has related chiefly to the varieties of individual modification, it is purposed to consider briefly, in this place, the characteristic circumstances of different kinds of weather. In doing this, I have taken examples of some of the most dissimilar varieties, though there are kinds of weather partaking more or less of each of them, so that the shades of difference are innumerable, every day, perhaps, having something different from all the rest in the

year: and if the different states of weather alluded to have any decided connection with the varieties of the animal functions, their effects must be very intricate and compound; a circumstance which has always rendered the knowledge of this connection so obscure and imperfect.

As there are many circumstances which constitute particular kinds of weather, and many combinations of these circumstances, it will be proper to adopt some one as a criterion, and speak of the combinations of the others under that head.

The order of the clouds is the most obvious feature in different kinds of weather, and ought to be principally attended to. There are several sorts of weather, which, to an inattentive observer, would be called, in common, fine wholesome weather; but, which, by a more minute observance, are found to differ materially, both in their appearance and consequences.

A stratus early in the morning, greater or less, according to time of year, etc. evaporating as the sun rises, the formation of well defined hemispherical cumuli through the day, most abundant soon after noon, and

disappearing again in the evening, to be succeeded by strong dew and a stratus, are the circumstances which mark a settled and wholesome state of the atmosphere, particularly when accompanied by westerly gales; which, though they do not vary directly as the sun's altitude, yet seem, in some measure, to keep pace with it, and a calm succeeds in the evening.

This order and distribution of the clouds happens with different winds, and different states of the thermometer; for it is not confined to hybernal frost, nor to the heat of the dog star. When it takes place, however, the mercury in the barometer is seldom very low, or variable. Indeed it may be said, in general, to be conjoined with a mean state of that instrument. This weather is of longer or shorter continuance, as may happen: the appearance of cirrus and cirrostratus, and, above all, the fleecy and irregular look of the cumuli, with sudden variations in temperature and pressure, indicate a change. Sometimes these appearances soon subside, and the same weather returns. The cumuli, too, occasionally become rocklike, approach to cumulostratus, and spread, without ending

in rain: but these are exceptions to the general rule. When to such a continuance of regular nubification, as described above, cirrocumulus supervenes, an increased warmth often follows, and frequently without rain. Occasional changes of this kind in the order of the clouds, unattended by rain, took place during the long drought, which continued from Midsummer nearly to Michaelmas, in the year 1800.

In days with the regular order of clouds alluded to, I have found the action of De Luc's electric column regular. Such days often alternate with others in which different modifications appear; and, very often after, cumulostratus, accompanied by cirrus, etc. has prevailed, for many days: nimbification and rain take place; after which, only regular cumuli are observed again; as if nimbification was a process which restored the tranquillity of the atmospheric electricity.

In spring and autumn we have frequently a continuance of cloudless days, ushered in by more or less of a stratus: but this very clear kind of weather seldom takes place about the solstices. The wind is usu-

ally Easterly, varying more or less to North or South, and often strong: the air dry; the mercury of the barometer usually above the mean altitude, and the range of the thermometer; that is, the distance between the maximum of the day, and the minimum of the night, is considerable. The falling of the dew in the evening, which is often plenteous, is indicated by the crimson or lake colour of the horizon for some time after sunset, which extends all around, except, perhaps, in the West, where the sky has a deep and rich golden appearance, approximating more to red, to yellow, or to orange.*

* It is very difficult to commemorate precisely the particular tints exhibited by clouds; yet this ought to be done as accurately as possible: for the different colours, refracted by the haze, with a horizontal sun, are very various, on different occasions, though the sun's distance from the horizon, either above or below, shall be the same. The haze, at different times, refracts almost every conceivable variety of purple, lake, crimson, orange, and yellow, and sometimes a brownish colour. The colour of the haze should be distinguished from that refracted by definite clouds. The latter also refract a great variety of colours, and sometimes many tints are seen in different parts of the same cloud. Though the infinite shade of colours will ever prevent the adoption of terms which shall define them precisely; yet a

Nearly a week of such clear weather happened during Sept. 1811, and afforded a good opportunity of making observations on the brilliant comet which was conspicuous that autumn.

A fine line of cirrus, of great altitude and length, is often the first sign that the clear weather above described is about to be changed for an atmosphere more variable; and, in proportion as such kind of cirri increase, and others, or clouds of other modifications, succeed, we may judge of the nearer or more distant approach of the alteration; and the weather about to follow may, in general, be determined by the general face of the sky, and of the kind of modifications apparent during the progress

much better nomenclature for colours might be invented, than has hitherto been done. It is obvious how indefinite the present terms in common use are. How different the red of the peony from that of the papaver rhaeas, and still more so from that of the papaver orientale, or the scarlet lychnis. The yellow of the crocus, or the marigold, from that of the evening primrose, or the ranunculus pratensis. Perhaps the best mode of forming a nomenclature for colours, would be by reference to specific flowers, which may be considered as standards.

of the change. But the great clearness above depicted often gives place to, and alternates with, a state of the atmosphere marked by peculiar circumstances, which seem to indicate a great disturbance, and perpetual change in its electric state.

In such weather, the cirrus generally appears soon after, and sometimes before, sunrise, and prevails through the day, under every conceivable variety of whimsical figures. Comoid tufts, like bushes of hair, or sometimes like erected feathers; angular flexures; streaks; reticular intersections of them, frequently at right angles, which look like nets thrown over the firmament; forms of arrows; stars with long fibrous tails; cyphon shaped curves, and lines with pendulous or with erect fringes, ornament the sky; still different appearances of stars and waves again appear, as these clouds change to cirrocumulus and to cirrostratus, which modifications also seem to form and subside spontaneously, in different planes,*

* Clouds are said to be in the same plane, when at equal distances from the earth; more properly, it is a portion of a sphere, whose diameter is greater than that of the sphere of the earth, by twice the distance from the earth's surface to the cloud. We speak familiarly of the plane surface of water, which is actually spherical.

and with the varied and dissimilar appearances of flocks at rest, fleeces of wool, or myriads of small specks; of long tapering columns, like the tail of the great manis, or of mackerelback skies, or of striae, like the grains of wood. Cumuli have not now their hemispherical figure; tuberculated, or fleecy; elevated and flimsy, or heavily sailing along like scud, they appear operated on by an unusual condition of their causes. All these circumstances, when viewed as perpetually changing and appearing at different times of day, and exhibiting innumerable and dissimilar tints, according with the sun's varying altitude, afford abundant amusement for the speculative observer, who delights in the highly diversified scenery of nature. But when we observe the relation of such multiform configurations of the clouds to other phaenomena, the varying and irregular action of De Luc's electroscope, the irregular strength and duration of the winds, the altitude of the mercury in the barometer, and to the state of other instruments, our curiosity is enhanced: and our desire further to develop the principles of such relations becomes yet, of more moment, when we find atmospheric peculiarities, of which

such appearances are tokens to influence the growth of vegetables, and to affect the functions of animal life.

The kind of weather above depicted continued through the chief part of the autumn of 1810, during which time such derangements in the action of the digestive system, as are commonly called autumnal diseases, were remarkably prevalent, followed by hypochondriasis, and other nervous affections. It was in the same season that the great mortality happened among the plane trees above alluded to. The weather of the said autumn was rather hot and dry, till about the middle of October, when it became damp, and rather rainy: but still there continued to be an unusual appearance of the clouds during the intervals of fine weather. A similar kind of dry weather occurred again in the spring, 1811, attended with similar phaenomena, and the irregular action of the aërial electroscope. But the summer and autumn following were remarkably fine aud wholesome, and very warm, though there were occasionally days in which similar multiform and ever changing configurations of the modifications prevailed.

Even showery weather is characterized by very different appearances of the clouds at different times. The stupendous and mountainlike cumuli and cumulostrati, which appear in the intervals of summer showers, have a different look from those which accompany the cold snow showers of spring, with keen March winds. Indeed, the rock-like cumulostrati, which are seen before such snow, have generally a well defined, though rugged margin, to appearance, and a peculiar look of transparency, or clearness, which is preserved even when they become dark purple, or nearly black.*

I have slightly mentioned these circumstances, from a belief, that in general the particular order and arrangements of the clouds are not sufficiently attended to. It is to be hoped, in future, that more attention will be paid to this part of the subject.†

* With such skies, I have known cold South winds; and on other occasions, with different kinds of clouds, hot northerly winds in spring. The peculiar appearances which attend these exceptions to the usual coincidence of phaenomena ought to be particularly attended to.

† There are many minute differences in the appearance of the clouds, under different circumstances, which

I have not described, as every meteorologist must observe them for himself. Sometimes there is a wavy appearance of the under part of a cumulostratus passing over, which looks like the white foaming billows of the ocean. This is generally a sympton of variable weather, as is also the curling inward of the fleecy protuberances of the cumuli, as they pass along in the wind.

CHAPTER IX.

SOME MISCELLANEOUS OBSERVATIONS ON ATMOSPERIC TEMPERATURE AND PRESSURE.

After the invention of the barometer and thermometer, many important discoveries, about the pressure and temperature of the atmosphere were made by philosophers. The knowledge, however, of their variations, and the relations of these variations with other phaenomena, remains still very obscure, and leaves a wide field for future investigation.

When Galilaeo and Torricellus had discovered, that the pressure of a column of atmosphere was equal to that of a column of mercury of equal base, and of about thirty inches in height, and to a column of water of the same base, and about thirty five feet in height: but, that the height of the mercury or water, which balanced the column of air, varied a little at different times, philosophers began to measure the atmospheric pressure by such means; and finding that its

variations were very irregular and uncertain, and were not referrible to any known laws, they began to investigate their causes. Without detailing the particulars of the observations made by philosophers, from time to time, it will be sufficient to observe, that the variations of pressure, as far, at least, as we can discover, may be caused, 1st, by a variation in the volume of atmosphere, the density remaining the same; or, 2dly, by a variation of density, the volume remaining the same; or, lastly, by a variation in both density and volume. But though these circumstances may be conceived capable of effecting barometrical variations, yet it is probable there may be many other causes yet unknown. Many hypotheses have been assumed to account for variations in the density and volume: but, after all, these do not seem capable of accounting for all the phaenomena which attend alterations in the atmospheric pressure. As it is not my intention to detail former experiments and hypotheses, I shall conclude this chapter with a few simple observations on facts, which I have made myself, many whereof do not appear to have been noticed before.

It is a common observation, that the fall-

ing of the mercury, when gradual, is followed by long continued rain; when it suddenly sinks, or sinks and rises alternately, by showers; and when greater or more sudden depressions take place, storms are generally the consequence. These observations are, generally speaking, true; though, perhaps, with occasional and rare exceptions; for sometimes the barometer shall sink, and even the clouds present all the appearances of rain, and yet the rainy symptoms shall subside, and clearness return without any fall. But there appear to me to be some other remarkable connections between the state of the barometer, and other phaenomena, which do not appear to have been noticed.

Rain, as is known, sometimes falls with a rising barometer; and, when this happens, it is usually followed by fine healthy weather. Some philosophers have called it rain of the recomposition of the air.* And I have noticed rain, with a rising of the mercury, to be attended with circumstances which seem to indicate a strong positive electricity.†

* Van Mons. Nicholson's Jour. Sept. 1809.

† The strong and refreshing smell, which sometimes results when showers first fall, after a long drought, is not

There is usually a warm and agreeable sensation of the atmosphere attending such rain, which is strikingly contrasted to the cold and raw sensation occasioned by the fall of thick wet mists, or rain which happens when, even with a northern or easterly wind, the barometer and thermometer sink together, and when the air has previously been found to be negatively, or nonelectrified.

As far as we can determine, the air appears capable of holding more water in solution, in proportion as its temperature and pressure is greater; and yet the thermometer often rises when rain is coming on, particularly in winter. This circumstance is not wholly irreconcileable with what has been laid down, since the rain may be occasioned by a diminution of pressure, as is often manifestly the case,

an invariable attendant on them, even under these circumstances. The highly electrified water of summer's thunder showers produces this smell the strongest; and it is weakest with the cold, and, perhaps, nonelectric rain, which sometimes falls after the condensation of a spreading sheet of cirrostratus into nimbus, with a cold atmosphere.

the barometer falling, or else by a supervening current of colder or supersaturated air; and the rise of the thermometer, which accompanies the fall of the barometer in this case, may be owing to the increase of temperature produced by the condensation of the vapour in the case of rain. But on what principle can we account for the increase both of temperature and pressure, during such condensation? On the 20th and 21st July, 1811, rain kept falling almost all day, with a rising barometer, and no depression of temperature, (making allowances for the interception of the sun's rays,) while evaporation continued to be considerable.

It has been remarked by Mr. Howard, that if the state of the barometer, during any period of the moon, be examined, it will be found to have been highest or lowest about the time of the full and new moon, as may happen; but that the mean state of that instrument usually happens about the lunar quadratures. As far as my own observations enable me to decide, this connection is observable in the majority of instances.

I once thought that the mean state of the barometer of a given number of days' observation varied, in some measure, according to the moon's perigee and apogee; that is, that it was higher with the latter than with the former: but subsequent researches convinced me, that the exceptions were almost as numerous as the cases corresponding to the rule.

I introduce the above circumstances here, merely that they may become the subjects of the future observations of meteorologists in different places; as I think they are worthy of a stricter examination than has hitherto been made.*

* If the place of the moon has such an effect on the atmosphere, as to influence the barometrical pressure, it may probably produce other varieties in the state of the air, which may influence the nervous system and animal functions of persons in particular kinds of disease. It is thus that it may have an effect on persons of such deranged intellect, as is termed lunacy, who are said, in some cases, to be worst about the full of the moon.

There are many other instances of periodical paroxysms of different complaints, and some of them very curious; but how far, and in what manner, solar and lunar influence is concerned, cannot be precisely determined. Some persons have had paroxysms come on at particular hours of the night, and have, for a long time,

awoke at those hours. To try how far the imagination has been concerned in producing the diseases, clocks have been altered to deceive the patient, but without avail. The reader may consult the Zoonomia of Darwin, and a recent work in France, by Ph. Pinel, Arnold on Insanity, Crighton on Mental Derangement, and others who have written on this subject.

Since the first edition of this book, I have conversed with Dr. Spurzheim, about the periodicity of disorders of health. He considers it as more or less affecting every body. The doctor is now employed in publishing a large work on the newly discovered anatomy and physiology of the brain.

CHAPTER X.

OF SEVERAL SUPERSTITIOUS NOTIONS WHICH APPEAR TO HAVE HAD THEIR ORIGIN IN AN OBSERVANCE OF CERTAIN METEOROLOGICAL PHAENOMENA.

THERE is a natural tendency in the human mind, arising from the mutual influence of the different organs of the brain, and the consequent association of ideas, to attach notions of good or evil to those objects which have been observed to precede or to accompany pleasurable or painful circumstances: hence the origin of many superstitious opinions.*

From such association of ideas many animals were anciently worshipped, either as good or evil spirits; and even at a later period, when their worship was rejected as superstitious, or useless, they were consi-

* In the figurative language of the ancients, facts were often ascribed to contemporaneous remarkable circumstances; hence the influence of Procyon or dog days, the blustering of the stormy Orion, and many others; see a memoir Sur l'Origene des Constellations et l'Explication de la Fable, by M. Dupuis.

dered as foreboders of evil or of good. Many of these superstitions originated in the observance of facts, ascribable to atmospheric influence.* Thus, certain birds being affected by peculiarities of the air, previous to thunderstorms, or other terrible events, and showing signs of their affections by particular habits, were found to be foreboders of tempests, hurricanes, and other dangerous atmospheric commotions; and they were subsequently considered as evil omens in general, gaining, as it were, an ill name by their utility as monitors. So the crow, garrulous before stormy weather, was afterwards regarded as a predictor of general misfortune. Many animals too were considered by the ancients as influenced by human prayers and supplications.† In this manner the observation of

* Some observations on the physical origin of such superstitions may be found in Cicero's work on Divination.

† Ego quae timebo,
Providus auspex
Antequam stantes repetat paludes,
Imbrium divina avis imminentum,
Oscinem corvum prece suscitabo,
Solis ab ortu. *Horatius.*

many real facts laid the foundation for superstitions, which terrified the ignorant, and which the designing made use of in order to acquire respect, and to aggrandize their own power. Hence the rise of sorcerers, augurs,* and other impostors, the interpreters of omens and portenta, who pretended, in the peculiar flight and song of birds, to read the destinies of monarchs and of nations. It is probable that out of a number of such predictions, some might happen to be true, where the sagacity of the augur penetrated farther into probable events than the ignorance of the multitude; and this fortuitous coincidence enhanced the public credulity, strengthened the empire of superstition, and became a fatal impediment

* Consuluitque stryges nostro de sanguine, et in me
Hippomanes foetae semina legit equae.
Propert. lib. iv. eleg. v. 15.

Aristophanes, laughing at the dependance upon the predictions of augurs, makes the birds ludicrously chant their importance in the following words:

Εσμεν δ' υμεν, Αμμων Δελφοι Δωδωνη φοιβε Απολλων
Ελθοντες γαρ πρωτον επ' ορνεις ϗτω προς απαντα τρεπεθε.

to the progress of science throughout succeeding ages.*

It may be proper to examine a few cases in point, for the sake of illustration. Among all the birds of evil report among the ancients, the owl stands foremost, as being the most generally regarded as the harbinger of mischief and of death. Pliny, the natural historian, represents the large-eared or horned owl, strix bubo, as a funereal bird, a monster of the night, the abomination of human kind.† And Virgil de-

* Among many remains of augury extant at the present day, may be enumerated the common practice among our farmers, of nailing up dead kites, crows, owls, weasels, and other rapacious animals, against the doors of barns and outhouses: a custom which originated, as Apuleius informs us, in an endeavour to terrify the infaustae aves, and warn them not to obtrude themselves upon the family; the superstitious often imagining that, by avoiding the omen, they could avert the impending mischief. *Quid, istas nocturnas aves, cum penetraverint larem solicitè praehensas foribus videmus adfigi, nisi quod infaustis volatibus familiae minantur exitium, suis luant cruciatibus.*

Apul. Met. lib. iii.

† Bubo funebris et maxime abominatus publicis praecipue auspiciis, deserta incolit, nec tantum desolata sed dira etiam et inaccessa, noctis monstrum, nec cantu aliquo

scribes its death howl from the top of the temple by night; a circumstance probably introduced here by the poet, as a precursor of the death of Dido.* Ovid constantly speaks of this bird as an evil omen;† and the same notions respecting it may be found among the effusions of most of the ancient poets:‡ indeed, there is scarcely a

vocalis, sed gemitu. Itaque in urbibus aut omnino in luce visus dirum ostentum est.

Plin. Hist. Nat. lib. x. c. 12.

Quis quaeso ovum bubonis videre possit, cum tam avem ipsam vidisse prodigium sit. *Plin.*

* Solaque culminibus lethali carmine bubo
Saepe queri, et longas in fletum ducere voces.

Virg. Aeneid. iv. 462.

† Foedaque fit volucris, venturi nuncia luctus
Ignavus bubo, dirum mortalibus omen.

Ovid. Met. v. 550.

Eumenides stravere torum tectoque profanus
Incubuit bubo, thalamique in culmine sedet.

Ovid. Met. vi. 432.

Ter pedis offensi signo est revocata, ter omen
Funereus bubo lethali carmine fecit.

Ovid. Met. x. 452.

Tristia mille locis Stygius dedit omnia bubo.

Ovid. Met. xv. 791.

‡ Nocturnaeque gemunt stryges, et feralia bubo
Damna canit. *Stat. Thebaid.* iii. 511.

poet, ancient or modern, who does not speak of the owl in this point of view.*

The bird called by the Greeks *βυας*, seems to be the same as the Roman bubo, and was also reckoned an ominous and ill fated bird.†

Hîc vultur, illic lucifer bubo gemit.
Senec. Herc. Fur. 686.

Bubilat horrendum ferali carmine bubo
Humano generi tristia fata ferens.
Epig. de voc. av. et quad. Anthol. vet. Lat. Ep. cxliii. 33.

Quod trepidus bubo quod strix nocturna queruntur,
Quod strident ululantque ferae. *Lucan*, lib. vi.

* The superstitious opinion, that the owl is the harbinger of death, still prevails among the ignorant of modern Europe. In England, no village ghost, or fairy dance, no pizgy maze, or haunted house, is more common than a death foretold by the owl.

The remarkable appearance of the upright shadows in some foggy moonlight nights, as well as some curious atmospheric refractions, have probably cooperated with ocular spectra, in giving birth to the monstrous relations of nocturnal spectra and apparitions, which so mightily terrify the country peasants.

† Jam si historicos consulas apud Dionem in morte Augusti, cùm decrevit senatus, ut publice supplicaretur propter ejus valetudinem, τοτε συνεδριον κεκλεισμενον ευρεθη, και βύας υπερ ἀυτȣ καθημενος ἔβυξε.—Et in morte Commodi Βυας απ᾽ αυτȣ (καπιτωλίȣ) ἔβυξε, etc.
Bochart. Hierozoicon, lib. ii. c. 22.

See also Arist. Hist. An. lib. viii. c. 3.

Some authors, too, have considered the καλχις as the owl: Homer identifies this bird with the χυρινδος,* also supposed by some commentators to be the owl.† The striking and peculiar look of this bird; its occasional and uncertain appearance in towns; and its loud and dismal cry, uttered often when all other birds are quiet, as well as its being the bird of night, are the circumstances which, aided by an occasional coincidence of events, have caused the owl to be regarded in the light of an evil omen. This, and similar superstitions, will appear less surprising, when it is considered that crafty and designing persons had an interest in their propagation.

The dread attached to owls seems to have been extended to other birds of the night; a circumstance which rather corroborates the idea that they were dreaded, in a great measure, from being companions of darkness and obscurity. Spencer has given us

* Καλχιδα κικλησκεσι θεοι ανδρες τε κυρινδον. *Homer.*

† There are a great variety of names for the owl, as well as for other birds, which, by all writers, except natural historians, since the time of Linnaeus, appear to have been used, in a great measure, promiscuously.

a most woeful catalogue of harmful fowls, in the second book of the Fairie Queene.* The hollow booming of the bittern from the pool on a still evening, and the hoarse sound of the nycticorax and fernowl, are equally striking; may be easily imagined plaintive; and seem capable, when uttered in the stillness of evening, of exciting ideas of melancholy; and of inducing in the minds of the vulgar and ignorant an idea of their being connected with misfortune.†

The cornix of the Romans was another bird represented as ominous, who, by his

* Even all the nation of unfortunate
And fatal birds about them flocked were,
Such as by nature men abhorre and hate,
The ill faced owle, death's dreadful messengere;
The hoarse nightraven, trump of dolefull drere;
The leather winged bat, daye's enemy;
The ruefull strich still waiting on the bere;
The whistler shrill, that whoso hears doth die;
The hellish harpies, prophets of sad destiny.

Spen. Fairie Queene, lib. ii. 12, 36.

The harpy has been supposed by some to be the Madagascar bat.

† How sweetly did they float upon the wings
Of silence, through the empty vaulted night,
At every fall soothing the raven down!

Milton's Comus.

croaking, prognosticated evil;* but, whether the cornix was the raven, or the crow, or, indeed, of what species, is uncertain. It was, however, some bird of this genus; and to identify the species is of more consequence to the natural historian than to the meteorologist. It does not appear that the cornix was the same bird as the corvus. The augurs appear to have represented one as a bird, which was ominous croaking on the right hand, namely, the corvus; and the other, on the left hand, the cornix; as observed by Cicero † in his book of Divina-

* Saepe malum hoc nobis, si mens non laeva fuisset,
De coelo tactas memini praedicere quercus,
Saepe sinistra cava praedixit ab illice cornix.

Virg. Ecl. i.

Quod nisi me quacumque novas incidere lites,
Ante sinistra cavâ monuisset ab illice cornix.

Virg. Ecl. ix.

See also Plin. Hist. Nat. lib. x. c. 12.

The word sinistra here seems to refer to a Grecian superstition about ill omens being given on the left hand, of which our poet was mindful when he said,

"That raven on yon left hand oak,
Curse on his illbetiding croak!"

Gay. Fab. &c.

† Jupiterne cornicen a laevâ, corvum a dextrâ canere jussisset? *Cicero de Divin.* lib. i. c. 7.

tion, and afterwards by Bulengius, in his book on Augury.

The picus was also another of the oscines, whose voice was feigned injurious to travellers.* This fable might have been founded on observing the garrulity of the bird before rain; which might become an impediment to a journey. Linnaeus represents this bird to have been the woodpecker, or pickatree; but it is difficult to identify the names and species of birds spoken of by the ancients.† The parra was another bird with whose illportending song Horace cursed the impious.‡

Cur a dextra corvus, a sinistra cornix faciat ratum.
Cicero de Divin. lib. i. c. 39.

Some make the Greek κοραξ to be the Roman corvus, and the English crow, and the Greek κορωνη to be the cornix of the Romans, and the raven of Great Britain. Linnaeus, however, has called the raven corvus corax, and the crow corvus coronae. I refer the reader to Aelian, Aristotle, Pliny, Gesner, and Aldrovandus.

* Teque nec laevus vetet ire picus
Nec vaga cornix. *Horat.*

† Picus may be only masculine of pica the magpie; a bird which, in windy and stormy weather, I have observed to be garrulous, and to fly high in small flocks, uttering its cry.

‡ Impios parrae recinentis omen
Ducat. *Hor. Od.*

It was long ago observed, as mentioned in another chapter, that the frequent immersion of certain fowls in the water portended rain; and they were, consequently, considered unlucky alites; while others, who never dived, were regarded as good signs; a fact observed by Niphus in his book of augury, who quotes a verse to that effect from Aemilius.* And Virgil makes Venus predict the safety of the Trojan fleet, to Aeneas from the flight of swans.†

Another familiar instance of the effect of association of ideas is the following— Vultures, who prey on carcasses, naturally fol-

* Cygnus in auspiciis semper laetissimus ales,
Hunc optant nautae quia non se mergit in undis.
Niphus de Auguriis, lib. 1. c. 10.

† Namque tibi reduces socios classemque relatam,
Nuncio et in portum versis aquilonibus actam,
Ni frustra augurium vani docuere parentes,
Adspice bis senos luctantis agmine cycnos,
Aetheria quos lapsa plaga Jovis ales aperto,
Turbabat coelo; nunc terras ordine longo,
Aut capere aut captas jam despectare videntur.
Ut reduces illi ludunt stridentibus alis,
Et coetu cinxere polum, cantusque dedere,
Haud aliter puppesque tuae, pubesque tuorum,
Aut portum tenet, aut pleno subit ostia velo.
Virg. Aeneid, i. 400.

lowed armies, and inhabited the field of battle after the conflict: the ancients, therefore, associated their appearance with destruction, and they became evil omens, particularly when following armies.*

There is a superstitious respect paid to the swallow, in many parts of the country, at the present day. Their nests are protected, and it is considered unlucky to molest them by accident: this is a very old opinion, mentioned by many writers: and the circumstances of their building so close to the habitations of man indicates, I think, that they have long enjoyed freedom from molestation.† For animals seem to regulate their conduct according to circumstances: and it is not only that the indi-

* Potter has some observations on this in his Antiq. Graec. and refers to Plutarch, Aristotle, and Pliny.

† ———— the martlett
Builds in the weather on the outward wall,
Even in the force and road of casualty.

Shakspeare.

Odimus accipitrem quia semper vivit in armis,
Et pavidum solitos, in pecus ire lupos,
At caret insidiis hominum quia mitis hirundo,
Quasque colat turres chaonis ales habet.

Ovid. Art. Amat. ii. 150.

vidual learns to avoid danger, but the whole species seems by degrees apprized of the state of either enmity or amity between them and man, and to act in conformity with this knowledge. There are parts of oriental India, where the religion of the Brachmans protects animals from injury, in which hawks and other birds are so familiar and daring, as to snatch the food from out of dishes, as men are carrying them from the kitchen to the place of repast. The respect paid to the swallow may have originated in its being the harbinger of spring, and from its inhabiting churches, temples, and other sacred places; and, perhaps in some measure, from its utility in clearing the air of insects.* Swallows, at one time, among the Greeks, appear to have been regarded as an evil omen when a flock of them settled on a tent, or ship.

* Ore bono volitans muscas deprendit hirundo,
Atque ita viventi pascitur illa cibo.
Quumque lacus circumvolitet vel florida prata,
Illius ambages quis numerare potest?
Cypselus at vacuo rapidis volat aethere pennis
Nec metuit milvos accipitremve feram.
Epig. Incert. Auct.

The low flight of swallows predicts rain, and their settling on buildings is an autumnal custom previous to their departure, or to the commencement of wintery weather; hence have they, perhaps, been considered as portending evil.

The crowing of cocks was reckoned ominous, particularly as prophesying the event of wars. It is from the known courage of this bird in combat, that he was sacred to Mars, and called Αρεος νεοττος by Aristophanes. The galli cantus presaged the victory of Themistocles over the Persians; and the feasts Αλεκτρυώνων ἀγών were called so from this event, and were celebrated by fighting cocks. And a victory of the Boeotians over the Lacedaemonians was also said to be foretold by the cocks. There are, besides the above, many other superstitions relating to cocks, all, apparently, coming from some observance of fact. At a later period, cocks were said to crow all night about Christmas time, a fable adverted to by Shakspeare in Hamlet.*

* Some say that ever 'gainst that hallowed season,
At which our Saviour's birth is celebrated,

This fancy is easy of explanation; for the crowing of the cock being the announcer of the dawn of light, he is said to crow all night at that season of the year, which, though really the darkest, namely, midwinter, was the season at which the light of Christianity was said first to dawn on the darkness of the Pagan world. There is a remarkable circumstance about the crowing of cocks. At several different times in the course of the night, a general crowing may be heard, from all quarters, where there are cocks: the first that begins, apparently setting all the rest off; and this fact is remarkably striking in places where numbers of cocks are bred for the purpose of fighting. As far as I can observe, excepting at the dawn of day, these crowing matches happen at very irregular and uncertain periods. The ancients, however, seem to have regarded them as taking place at marked in-

The bird of dawning croweth all night long.
The nights are wholesome, then no mildew falls,
No planet strikes, nor spirits walk abroad;
No fairy takes, nor witch hath power to charm;
So gracious and so hallowed is the time.

Hamlet.

tervals of time which appear to have caused their division of the night watches by the first, second, and third, Αλεκτροφωνιας, as mentioned by St. John.*

They say that if a dead kingfisher be hanged up by its bill, its breast will always be turned to the quarter from whence the wind bloweth; this when the wind is strong may be accounted for mechanically from its shape, but it is asserted to be the case always; and the bird called therefore the natural weathercock.†

It is an old observation, that the appearance of a certain beetle, called tenebrio mortisagus, was a presage of death, which may be founded on observation. For the appearance of the insect may, in reality, forbode the death of sick persons in the house where it is observed; since the same peculiarity of atmosphere which may bring out the beetle, may be such a one as would produce the death of the patient.

* Some observations of this may be found in vol. i. of Dr. Hales's Analyses of Ancient Chronology, 4to. London, 1810.

† See Pseudonia Epidemica, by Dr. Brown, 2d edit. p. 104.

If it be by some such association of ideas as what has been above described, that most of the superstitious devotion paid to particular birds and animals has originated, the worship of the Ibis, and of the Scarabaeus in Aegypt, and of many other animals in Asia and Africa, might prove, if we were able to trace them, to have sprung from a similar source.*

The popular persuasion, that if it rains on the 15th July, called St. Swithin's day, it will rain some part of each day for forty days, may be ranked among superstitious notions originating in atmospheric phaenomena; for though the placing the prognostic at St. Swithin's day must palpably be the effect of ignorance and credulity, yet there may be some natural reasons why, if rainy weather occur about that time of year, it will be of some continuance, which I have noticed for many years to be the case.

In parts of Wiltshire, they say, it is unlucky to look at the new moon, for the first time, through a glass; showery weather

* Some animals appear to have become sacred, from their absolute utility, as the tame Ichneumon in parts of Aegypt.

about that time of the moon, which might keep the spectator in doors, and make him see her crescent first through a window, may be a bad prognostick for the month. The ignorant run out of doors and turn the money in their pockets, if they hear by chance of her first appearance. Many people positively assert that Friday is always either the fairest, or the worst day in the week: what this originated in, unless it were some casual occurrence of a succession of fine and of wet Fridays, I know not. Numerous other similar errors of reason might be added, were it necessary to confirm the unlucky devotee of fable and fancy, who is cursed for walking under a ladder, or toward whom the salt fell on a Friday, that he is perverting physical truths by his own disturbed imagination. The idle tales about Pandora and about Fortune, and many others, are referrible to a physical origin. Idleness too is a great propagator of superstition. The inactivity, anxiousness, and mystic feelings of some minds, viewing the great uncertainty of future events, and the casualties of life, render persons more disposed to trust to their stars than to their wits, who con-

tent themselves with praying to the goddess not to crush their fabric, and, like Horace of old, sing

> "Injurioso ne pede proruas
> Stantem columnam.""

While others of a different turn of mind, preferring prudence to fancy, and choosing rather to apply their shoulders to the wheel than to call on Hercules, chant the more sensible song of

> "Nullum numen habes si sit Prudentia, quamvis
> Te facimus Fortuna deam coeloque locamus."

The different successess in life of these two kinds of persons are well discussed in Miss Edgeworth's excellent story of Murad and Sanadin.

It would be foreign to the present subject to consider here any superstitious opinions which are not referrible to meteorological phaenomena; and only a few of these can be selected, for want of room. Any capable person, however, who would write a general history of superstitions, and endeavour to trace each to its particular source as nearly as possible, arranging them according

to the age or country in which they prevailed, and including all degrees of superstitious opinions and customs, from those which have gained importance from their extensive prevalence, and the influence they have had on the manners and destiny of different people, down to the meanest subject of terror to the village peasant, would render considerable service to the cause of truth. Such a book, translated into different languages, and distributed among different nations, might be of great use, in clearing up many injurious fables and preparing the way for useful knowledge.

APPENDIX.

C. 1. § 4. *p.* 14. *l.* 12.—The sudden and dense fogs which come on sometimes seem hardly referrible to any assignable cause. In great cities, the fog, whatever may be its cause, aggrandized and thickened by smoke, and the breath of the inhabitants, often envelopes the whole town in such darkness, that people are obliged at mid-day to go about their business by candle light. Of this, I select the following instance from Mr. Howard's Journal, which happened on the 10th Jan. 1812:—" London was this day involved, for several hours, in palpable darkness. The shops, offices, &c. were necessarily lighted up; but, the streets not being lighted as at night, it required no small care in the passenger to find his way, and avoid accidents. The sky, where any light pervaded it, showed the aspect of bronze! Such is, occasionally, the effect of the accumulation of smoke between two opposite gentle currents, or by means of a misty calm. I am informed that the fuliginous cloud was visible, in this instance, from a distance of forty miles. Were it not for the extreme mobility of our atmosphere, this volcano of a hundred thousand mouths would, in winter, be scarcely habitable!"

An account of several remarkable circumstances attending particular fogs may be found in Bertholon.

Elec. des Meteors: also an account of the remarkable fog which overspread part of Europe in 1783. See vol. ii. 128. of the above work, *sur l'Extraordinaire Brouillard de* 1783.

C. 2. § 7.—A disposition in the air sometimes to form rain, without the precurrence of the modifications, may be deduced from the drops of rain which sometimes fall without any visible clouds, even when the sky is clear. The drops, probably, acquire size in falling.

C. 2. § 11. *Hail.*—It is a question, Whether hail results merely from the coldness of the atmosphere in which the nimbus pouring it exists, or whether some other causes may not be deemed necessary? Certainly there is a difference in the general appearance of the cumuli, cumulostrati, &c. which precede hailshowers, and showers which only effuse rain. The Abbé Bertholon has observed, that hard hailstorms are generally accompanied with thunder and lightning, and that the loudest thunder generally happens when the hail has been greatest. "La tonnerre gronda, sans interruption, pendent la chûte du fameuse grêle observé par M. de Ratte à Montpellier, le 30 Janvier, 1741. Il en a été de même dans un grande nombre d'autres circonstances." *Elect. Met.* ii. 195. ch. *sur la Grêle et le Gresil.* In the same work, vol. ii. cc. 6 and 7, the author has treated amply on the peculiarities of hail and snow.

C. 5.—To ascertain that our health is influenced by atmospheric peculiarities, is a discovery of little practical utility, unless it enable us to provide an antidote against their effects. The difficulty of guarding against such disorders as seem to be caused by the state of the air,

must appear manifest to all who consider the obscurity which hangs over this subject, both as to the peculiar quality of the air which excites the disorders, and as to the state of constitution of the patients in whom they may occur. As we do not know the nature of the specific stimulants which excite many atmospheric or other diseases, nor any particular counteracting antidotes, in medicines, we must be content to prescribe a general mode of conduct to those in health, which, by preserving a strong and tranquil condition of body, may avert or mollify the influence of the atmosphere on the constitution, and to endeavour to restore those already disordered, by measures that are generally known to conduce to such a state of health. It may not, therefore, be entirely foreign to the present subject, to discourse briefly on the mode of preserving the healthy, and of rectifying the disordered, actions of the animal machine. Early rising, good air, and exercise, freedom from care and anxiety, and temperance of appetite, have been from time immemorial the popular receipts for health and longevity; but the quantity of exercise necessary, the quantity of our food, and the periods of taking it, and its quality, which involves the question of natural diet, must be submitted to a more accurate and physiological scrutiny, which may, in a great measure, explain the ill success of many who labouring under disorder, yet think themselves entitled to health from the observance of an imagined course of temperance. Exercise should be taken to a considerable degree, but by no means when the stomach is full. Various experiments have long ago established it as certain, that digestion is never so well performed, as when a meal is followed by rest; and carnivorous animals, and, indeed, all those who take in their food in

any quantity, rest or sleep after their repast. Exercise, under favourable circumstances, seems to give vigour to the whole system; and strength appears, to a certain degree, to be commensurate to bodily exertions, and health and spirits are the consequence. Indeed few persons know how rightly to appreciate considerable and constant exercise in the open air as a medical agent and preserver of health. But it is probable, that the same vital energies, which are concerned in all the movements of muscular activity, and of thought, and which customary language has ascribed to the brain and nervous system, are engaged after taking our food in the work of digestion. And it has been found, conformably to this notion, that exertion after meals has interrupted the chylopoietic processes, and has caused unpleasant feelings in the stomach, and subsequent weakness. Great mental exertions, or anxiety, have had the same effect. The gentle stimulus of company after dinner, may, perhaps, be beneficial, by assisting to produce those nervous energies, which hard exercise might dissipate among the muscles at a time when they ought to be spent on the stomach, that that organ might pour out sufficient of the gastric juice to convert the alimentary matter into chyme, and subsequently on the liver, pancreas, and secretory coats of the intestines; that by the after aid of their proper fluids, the chyle may be properly formed for absorption and nutriment. Exercise, while these processes are going on, may be regarded as an interruption to them: though, if used several hours after eating, it appears often to assist the peristaltic action of the intestines.

The food is the next subject of consideration. It has been often said, that, in a natural state, the

quantity and quality of our food would be regulated by desire and opportunity: but as we know little about man in a natural state, we must regulate our diet by the experience of what is best in a state of artificial society. Physiologists have laid great stress on proportioning the quantity of food to the power of the stomach; and it is rational to consider, that what is not digested, will irritate the surfaces of the alimentary canal, and cause many sympathetic diseases. Hunger is, in health, the general criterion of the power to digest; but, in disorder, as Mr. Abernethy has observed, the uneasy feelings of a weak stomach are often mistaken for it.

Custom has, in artificial life, appointed meals at certain stated hours; a practice which does not appear to have arisen wholly from oeconomical convenience, but which may have been established, partly in order to embrace the beneficial results of conviviality, which consist in the pleasurable sensations, and, perhaps, better digestion, occasioned by cheerful company during and after meals. The wassail bowl, though abused by posterity, was, probably, suggested by the sagacity of our forefathers, as a salutary pleasure. The periods of eating should not come too near together. People fall into a mistake often by supposing that persons with weak stomachs should eat little, and frequently; whereas they ought really to allow considerable time for the digestive organs to recruit their strength. And many who for ill health have tried various kinds of food without success, have found great benefit from a long fast before dinner. Of the quality of food proper for man, much has been said and written by physicians in all ages, and various have been their opinions. Many have enjoyed good health who have subsisted entirely on a vegetable diet; while others have

grown weak, and have not been sufficiently nourished by it. In some particular diseases patients have not been able to eat vegetable food, and in others animal food has appeared injurious; but we must not draw our conclusions of the wholesomeness of any particular food from its effects on diseased subjects. There are many idiosyncrasies which must be regarded as exceptions to general rules: some persons cannot eat honey, others butter, others other things, without being ill. There are persons who can eat all meat but mutton which never digests with them. It may be proper to consider, first, what sort of food is best in health: and, secondly, what may be the medical influence of different changes of diet in cases of disorder. With regard to the first of these questions, little enough can be expected from any hypothesis of the cause of diseases. It is a question to be solved by an accurate examination of facts. We cannot even place much dependance on the analogy of the human structure to that of any other animal; for though the structure of the human organs of digestion most resemble those of carnivorous animals, yet the monkey tribe, which, in many respects, approach nearest in their nature to man, live on vegetable substances. Several writers of physiology have asserted, that those persons who feed on a mixture of animal and vegetable food are stronger and more active than those who subsist entirely on vegetables; while the advocates for a pure vegetable diet contend, that it produces more tranquillity, and even a more mild and amiable character. These two assertions are by no means irreconcileable, and agree very well with experiments and observations that I have made, which have had a tendency to show that animal food produces more muscular strength and energy, but,

at the same time, renders the body more susceptible of irritation. When, to patients who have long subsisted entirely on vegetable food, flesh has been superadded, the pulse has become quicker, the muscular motion more quick and lively, the countenance more highly coloured, and the spirits exhilarated. These effects are strikingly conspicuous just after the adoption of the meat, and illustrate the greater degree of stimulus afforded by animal food: and the contrary effects often appear on first taking to vegetables alone. But after a time, in either case, a very similar state of health often returns: a fact which illustrates the great power of accommodation to circumstances, which the human constitution possesses.

But though there be persons enjoying health on each diet; yet, upon the whole, the mixed diet seems to agree best with the majority, and also to produce rather more strength and vigour. But whether health maintained on a mixed diet be equally lasting, or whether it may not eventually lead to disease, is a question to solve which accurate experiments are as yet wanting. It has been said by those who contend for a vegetable diet, that, being natural, it conduces to a more perfect form of body, and greater degree of intellectual power. The assertion, however, seems not to be supported by facts; for the antient Greeks, who may be admitted as examples of the more perfect forms of our species, and who possessed a clearness of intellect, and vigour of imagination, superior to their neighbours, appear to have lived on a mixed diet; whereas the inhabitants of part of India, who subsist wholly on vegetables, are very far from either bodily or mental excellence.

For the medical advantage of vegetable diet, much more may be said, than for its common use. To illustrate the view I have of this subject, I must observe,

that the effect of animal food seems to be that of increasing all the vital energies, or actions, of the animal machine: while a person is in health, when these actions are natural, to increase them is to augment the strength and power of the animal: but, in diseases where there are morbid actions, to increase them is to aggravate the disease. It is probably on a similar principle that vegetable diet and distilled water are useful in diseases, where the diseased actions seem as fully established as the natural ones, as in cancer, for instance. Besides this, in common and more trifling cases, a mild diet may become a useful alterative, and, by alleviating the irritation of the chylopoietic organs, may subdue numerous sympathetic diseases, which accompany a disordered state of the viscera. This lowering of the animal actions by vegetable food has sometimes disposed me to differ from those who regard animal food as equally conducive to longevity, and to incline to the fanciful opinion of others, who have regarded the vegetable diet of the early ages as the cause of the Patriarchal longevity, as if man lived longer by living slower. All reasoning of this sort must, however, be very vague and conjectural. The question, whether the animal system wears out sooner in proportion as it is stimulated to action, either by animal food or any thing else, provided that stimulus does not proceed to cause actual disease, must rest entirely on experience. There are some remarkable instances of men, of what is commonly termed genius, that were characterized by perpetual activity of thought who have died prematurely: but there are several means of accounting for this. Men of genius are men of great sensibility, who are frequently led into excesses in eating and drinking, particularly the latter, which shortens their lives. Indeed, the stimulus of wine and spirits,

so uniformly destructive, seems, in a great measure, conducive to the enterprizes of genius. By exciting a system, already highly susceptible, into violent action, it gives, for a time, a flow and vigour to thought, but which is ultimately exhausting. Such persons seem to keep up an habitual state of excitement, similar to that which ordinary persons occasionally make use of, previous to any unusual mental exertion, who take drams as a stimulus. After all, notwithstanding the violence of stimuli is lessened by habitual use, from the diminution of excitability, it is doubtful whether the moderate stimulus of animal food actually hastens dissolution. Old Parr and Jenkins do not appear to have fed on a vegetable diet; and the longevity of Cornaro seems to have depended more on his moderation in diet, than on the quality of his food. Animal food is certainly as easily and as soon, if not sooner, digested; and to state the question of diet fairly, would be to say, in cases where from the healthy state of the digestive organs, the chylopoietic functions go on perfectly, what difference is subsequently observable between the effects of the mixed, and those of the purely vegetable nutriment? I was once inclined to attribute much good to the vegetable regimen as general diet; but subsequent experiments and observation have made me somewhat sceptical on this point. Animal food appears to afford more nourishment, in proportion to its volume, than vegetables. There may, perhaps, be minute differences in the quality of the blood, arising from different kinds of food, which evade all chemical tests; but, as we know nothing of these, we ought not to be deluded by hypothetical arguments on the subject. As the digestive processes are those of assimilation, the blood seems more likely to be deteriorated by bad chylification and absorption of unassimilated matter, arising from disorder in the organs,

than from the quality of the aliment, when the stomach is healthy. In disease, the blood may be altered in composition, from various sources; the liver and other secreting organs not giving out their proper fluids, and these remaining in the blood may alter its properties, and increase and render compound the evil of sympathetic irritation.

To preserve health, of which we are in actual possession, and to cure disorders when once established, are certainly very different things: in the latter case, various kinds of diet, like medicines, having specific actions arising from the nature of the disorder, particular regimen may become necessary, in some particular complaints, which it is foreign to the purpose to discuss here: but, in general, the treatment of diseases seems more simple than is usually imagined. As the secondary and outward symptoms of diseases are infinitely numerous and dissimilar, both as to their local effects on the body, and as to their influence on the mind, arising from varieties of constitution and other circumstances, the only rational and simple mode of treating them seems to be, to find out, if possible, whether, among the multiform symptoms, there be not some circumstances common to all diseases, and which are the distinguishing marks of disorder in the system. The antients seem to have pursued and acted upon this simple mode of investigation: and perceiving a manifestly disordered state of the digestive viscera to accompany the more obscure irregularity in the nervous actions, had recourse to remedies which had known effects on those organs; and they treated successfully the more apparently mental diseases, by rectifying the state of the viscera. The manner, the mind, and nervous system, and the digestive organs, mutually aggravate each other's disorder; and the insufficiency of local remedies n general, for

the cure of local diseases, has been ably illustrated by physiologists of late; which illustration may be regarded as the only important progressive step the science of medicine has taken since the time of Hippocrates. These opinions seem spreading on the continent, as may be learnt by the works of the French physicians, Hallé, Cabanis, Pinel, and others. Dr. James Hamilton, Dr. Curry, Dr. Cheyne, and some others, have, in this country, illustrated the connexion between the unhealthy state of these organs and diseases in general: and Mr. Abernethy, the perusal of whose surgical works first induced me to consider these subjects accurately, has shown the great success of the constitutional treatment of local diseases; and has treated in a very scientific manner of the disorders of the constitution, in which they orginate, and of the mode of treating them; to which works I refer the physiological reader.

I cannot help observing, in conclusion, that the pursuit of this subject strongly impressed me with sentiments of its importance, in a moral point of view. For if disorders in the digestive functions, which are so easily occasioned, and which are remediable by early attention, be capable, by getting ahead, of exciting the system in such a manner as to produce innumerable forms of bodily disease, and frequently to affect the operations of the mind; considering how general are these disorders, and the mistaken habits which produce and aggravate them, we cannot but regard them as principally efficient in producing the quantity of intellectual depravity, which is so widely conspicuous; and by weakening the mind, and perverting the character, as impeding the progress of science, and the advancement of truth. That the air, which seems to effect such great changes of the blood in the lungs, should, when its quality is peculiar,

by affecting those organs and the skin, cause great changes in the whole system, is no matter of wonder; but surely all these effects must be greatest on a weakened and disordered constitution. The way, then, to become prepared against atmospheric influence, is to tranquillize and invigorate the constitution by a systematic plan of temperance, founded on physiological views of the nature and offices of the chylopoietic viscera, and of the connexion of their disorders with those of remote organs, and of the system in general; and, at the same time to adopt habits of seasonable exercise abroad, and to enhance, by moral discipline, an habitual state of mental tranquillity, to which such habits tend. For by joining measures, which seem primarily to ameliorate the condition of the nervous system, with those which more directly regulate the chylopoietic organs, we place the functions of the animal system in a state the most favourable to health, which gives the greatest scope and range to intellectual exertion, and which fortifies the body best against the numberless diseases which the varieties of climate, and of atmosphere, may have a tendency to produce on the various degrees of strength and the peculiarities of organization of different individuals.

The reader who wishes to pursue further the effect of atmosphere on health may consult *Cabanis Rapport du Moral et du Physique de l'Homme.* 2d vol. pp. 1. 161.

C. 6.—There are some circumstances about winds very remarkable, and which seem inexplicable on any hitherto invented hypothesis. The gusts of wind, in some high windy weather, seem to fluctuate in a manner somewhat analogous to the undulatory motion of waves. This fact may be easily seen by a pendulous anemometer. When the wind is accompanied by the rain, the periods of the gusts may be counted by the intervals of the

more or less violent impulse of the water on the windows opposed to the wind, or leaves of any tree twined across them.*

In the *Phil. Trans.* vol. xlviii. 1. is related a curious instance of a violent gust of wind, which succeeded a flash of silent lightning, and came from the same quarter.

Winds.—Refer to D'Alembert's *Reflections sur les Causes Générales des Vents,* and to several papers in *Phil. Trans.*

The number of different currents blowing at the same time at different altitudes, is a circumstance I ascertained by the following experiments. On the 25th Oct. 1809, a gentleman, named Wallis, sent up a small inflammable air balloon from Clapton, in Hackney: the balloon was made of varnished paper, quite water proof, three feet six inches in diameter, and filled with inflammable gas. The process of filling it was begun at one o'clock in the afternoon; and by about ten minutes after two, the balloon appearing sufficiently inflated, a small paper parachute was attached to the bottom of it, by means of touch string. It was now found that the buoyant power of the balloon was just sufficient to carry the appendage. Upon the touch string being lighted, the balloon was launched into the air. At first it ascended very slowly in a direction nearly W. N. W. and in less than a minute dropped the parachute, which fell into the brick field opposite Hackney New Church. The balloon now ascended more rapidly in the same direction for several minutes, when, being very high, it met a different current of air, and was observed to travel nearly towards the South: this was ascertained

* The philosopher watching this, as he lies in bed by night, must be very careful to preserve his vigilance, as it is a most soporific sound. No lute of Mercury, or Aeolian harp, is more lulling to the Argus eyes of the student.

by the balloon's getting much more southward without increasing or diminishing in apparent magnitude, which it would have done, if it had taken a course either much to the East or the West of the South. In a few minutes more its course was again altered by a third current of air, which carried it in a direction apparently N. E., when it passed again over the northern part of the parish of Hackney, and was distinctly seen from the place of its ascent. At about twenty minutes before three, it was blown by a fourth current nearly N. N. W. by N. Thus there appear to have been four different currents above one another, namely, E. S. E.—N.—S. W. and S. S. E. by S. It very soon became invisible to the naked eye, but was discerned through a telescope till about ten minutes before three, when the person who sent it up observed it to sink very rapidly, after which it was no more seen.

At the time the balloon ascended, the mercury in the barometer, 30 feet from the surface of the earth, stood at 30. 28. Thermometer (Farenheit) 57½. Hyg. 0. 5. Wind variable and very gentle: a few clouds in the sky of the modification of cirrus.

This air balloon fell at five minutes before five, the same day at Wilbraham, near Cambridge. The sudden diminution of the angle of its altitude, which has been called its sudden descent, could not be occasioned by any rent in the balloon, since it afterwards travelled nearly fifty miles. At ten minutes before three it appeared in the telescope to be well distended: it is therefore probable, that at that time it had attained its greatest elevation. Its motion was, therefore, horizontal; and it being about twenty-five miles in the hour, and direct from the eye of the observer, it would, without any descent of the machine, occasion a rapid alteration of the angle subtended by the line of its perpendicular al-

titude. The diminution of the angle being rapid in proportion to any other observation, it was concluded that it must have been at that time descending, because we could not at that moment know the velocity of the current, which the time and place of its descent have since proved to be very great.

A small balloon launched the same day went uniformly in the same current of air. Since the above, I have made upwards of thirty experiments with air balloons, some filled with inflammable gas, and then with rarefied air. Some few of them have gone uniformly with one direction, but most have indicated four or five, and some seven or eight, different currents of wind: the currents below, too, have several times acquired successively the direction of those which had previously blown above.

C. 7. *Electricity.*—Though the antients might be unacquainted with the science of artificial electricity, yet they appear familiar with many electric phaenomena, as observed by M. l'Abbé Bertholon, in his *Ouvrage de l'Electricité des Meteors*, 2 vols. 8vo. *à Lyon.* 1787, vol. i. p. 67. The same author refers to a Dissertation, by M. Ostertag, *De Auspiciis ex Acuminibus.* Some observations on this head may be found too in the *Mem. Phil. Soc. Manchester.* Among other accounts I transcribe a part of the observation of the Abbé Bertholon, as follows: from his work above alluded to.

" *Des Phénomenes d'Electricité Naturelle, observés par les Anciens.*—Quoique la découverte d'electricité du tonnerre soit toute récente, on en trouve cependant chez les anciens des traces si certains, et si sensibles, qu'on ne sauroit en douter avec fondement. Nous allons rapporter plusieurs preuves qui établissent cette assertion d'une maniére irréfragable; elles sont appuyées sur des faits qu'on avoit eu de la peine à expliquer avant la con-

noissance de l'electricité atmosphérique. Il conste par Hérodote qu'on pouvoit, il y a plus de deux mille ans, attirer la fondre avec une pointe de fer! Selon cet auteur, les Thraces désarmoient le ciel de ses foudres en décochant des fleches en l'air, et les Hyperboréens en lançant pareillement dans les nuées, des piques améres d'un fer pointu. Ces usages sont autant de points qui conduisoient à la decouverte de l'électricité que les Grecs, les Romains, connoissoient par certains effets qu'ils attribuoient aux puissances célestes, comme M. Ostertag l'a prouvé très au long dans une dissertation de Auspiciis ex Acuminibus.

"Au rapport de Pline, les annales font foi qu'au moyen de certains sacrifices, et de certains formules, on peut forcer la foudre à descendre, ou du moin l'obtenir du ciel. Une ancienne tradition porte que cela a été pratiqué en Etrurie chez les Volsiniens, à l'occasion d'un monstre nommé Volta, qui, après avoir ravagé la campagne, étoit entré dans leur ville, et que ce fut leur proprerio, Porsenna, qui fit tomber sur ce monstre le feu du ciel. Lucius Pison, écrivain d'un grand poids, décrit au premier volume de ses annales, qu'avant Porsènna, Numa Pompilius avoit fait souvent la même chose; et que, pour s'être écarté du rit prescrit dans l'imitation de cette pratique mystérieuse. Tullus Hostilius fut lui-même foudroyé parmi les bois sacrés, comme de nos jours M. Richmann l'a été à Petersbourg, en répétant l'expérience de Marly-la-Ville avec trop peu de précaution. Tite Live rapporte le même fait de Tullus Hostilius. Les anciens avoient admis aussi un Jupiter Elicien, Elicium quoque accepimus Jovem. Jupiter qui, dans d'autres circonstances, étoit appellé Stateur, Tonant, Férétrien, avoit dans cette occasion le nom d'Elicien. Pendant la nuit qui précéda la victoire que Posthumius remporta sur les Sabins, les jave-

lots Romains jettoient la même clarté que des flambeaux. Lorsque Gylippus alloit à Syracuse, on vit une flamme sur la lance. Gylippo Syracusa petenti, visa est stella super ipsam lanceam constitisse. In Romanorum castris visa sunt ardere pila, ignibus scilicet in illa delapsis: qui sæpe, fulminum more, animalia ferire solent et arbusta, sed si minore vi mittuntur, defluunt tantum et insident, non feriunt nec vulnerant.* Suivant Procope, le ciel favorisa du même prodige le fameux Belisaire dans la guerre contre les Vandales.† On lit dans Tite-Live, que Lucius Atreus ayant acheté un javelot pour son fils, qui venoit d'être enrôlé parmi les soldats, cette arme parut embrasée, et jetta des flammes pendant plus de deux heures sans être consumée par le feu.‡ Plutarque, dans la vie de Lysandre, parle d'une apparence lumineuse qu'on doit rapporter à l'électricité: dans le chapitre trente deuxieme il fait encore mention de deux faits de cette nature. "In Siliciâ militibus aliquot spicula, in Sardiniâ muro circumeunti vigilias equiti, Scipionem, quem in manu tenuerat, arsisse, et littora crebris ignibus fulsisse." Les piques de quelques soldats en Sicile, et une canne que portoit à sa main un cavalier, en Sardaigne, parurent en feu. Les côtes furent aussi lumineuses, et brilloient de feux fréquens. Pline a observé le même phénomene. J'ai vu, dit-il, une lumiere sous cette forme, sur les piques des soldats qui étoient en faction la nuit sur les ramparts, vidi nocturnis militum vigiliis inhærere pilis pro vallo fulgorem effigie ea—hominum quoque capiti vespertinis horis magno præsagio circumfulgent.§ Cesar, dans ses Commentaires, rapporte que pendant la guerre d'Afrique, après

* Senec. Natur. Quaest. lib. i. cap. 1.

† Procop. de Bell. Vandal. lib. ii. cap. 2.

‡ Tite Live, livre xliii.

§ Plin. Hist. Nat. lib. ii.

un orage affreux, qui jetta toute l'armée Romaine dans le plus grand désordre, la pointe des dards d'un nombre de soldats brilla d'une lumiere spontanée; phénomene que M. de Courtivron * a appliqué le premier à l'électricité. Rapportons ici tout au long le passage de Cesar. Vers ce temps-la parut dans l'armée de Cesar un phénoméne extraordinaire, au mois de Fevrier: vers la seconde veille de la nuit il s'eleva subitement un nuage épais, suivi d'une grêle terrible; et la même nuit, les pointes des piques de la cinquième légion parurent s'enflammer.

"Per id tempus ferè Caesaris exercitui res accidit incredibilis auditu, nempè vigiliarum signo confecto, circiter vigilia secunda noctis, nimbus cum saxea grandine subito est cohortus ingens; eâdem nocte legionis quintae cacumina sua sponte arserunt." †—Tous ces faits que nous venons de tirer des anciens, prouvent qu'on a dit avec raison, que pour juger sainment des ouvrages des anciens, il faut penser qu'il y a beaucoup de fabuleux dans leurs histoires, et beaucoup de vérité dans leurs fables; que nous croyons trop facilement les premiers, et que nous n'examinons pas assez les secondes pour entirer les vérités utiles qu'elles renferment. Joignons ici d'autres faits analogues, observés par les modernes, qui tous prouvent l'indentité rigoureuse qui regene le tonnerre et l'électricité.

Sur un des bastions du château de Duino, situé dans le Frioul, au bord de la mer Adriatique, il y a, de temps immèmorial, une pique dressèe verticalement la pointe en haut: dans l'été, lorsque le tems paroît tourné à l'orage, le soldat qui monte la garde en cet endroit, examine le fer de cette pique, en lui présentant de près

* Histoire de l'Académie, 1752, page 10.

† Caesaris Comment. de Bello Africano, cap. vi.

le fer d'une hallebarde (brandistoco,) qui est toujours là pour cette êpreuve: et quand il s'appercoit que celui de la pique étincelle beaucoup, ou qu'il y a à sa pointe une petite gerbe de feu, il sonne une cloche qui est auprès, pour avertir les gens qui travaillent aux champs, ou les pêcheurs qui sont en mer, qu'ils sont ménacés du mauvais tems; et sur cet avis tout le monde rentre. La grande ancienneté de cette pratique est prouvée par la tradition constante et unanime du pays, et par une lettre du P. Imperati benedictin, datée de 1602, dans laquelle il dit, en faisant allusion à cet usage des habitans de Duino: "Igne et hastâ hi mire utuntur ad imbres, grandines procellasque praesagiendas, tempore praesertim aestivo.* M. Watson rapporte, dans les Transactions Philosophiques,† que, selon plusieurs rélations venues de France, M. Binon, curé de Plauzet, avoit assuré, que pendant vingt-sept ans qu'il y a résidé, les trois pointes de la croix du clocher paroissoient environneés d'un corps de flamme, dans les grandes tempêtes; et que quand ce phénomene s'étoit montré, la tempête n'étoit plus à craindre, le calme succédant aussi-tôt. M. Pacard, secrétaire de la paroisse du prieuré de la montagne de Breven, vis-à-vis le mont Blanc, faisant creuseur les fondemens d'un chalet qu'il vouloit construire dans les *prairies de Plianpra*, il survint un violent orage, pendant lequel il se réfugia sous un rocher peu éloigné, et il vit le feu electrique tomber à plusieurs reprises sur la tête d'un grand levier de fer planté en terre qu'il avoit laissé en se retirant.‡ Si on monte sur la cîme d'une montagne, on pourra être electrisé dans certaines circonstances immédiatement, et sans ap-

* Lettera di Gio. Fortunato Bianchini. dott. medic. intorno un nuovo fenomeno elettrico, all. Acad. R. di Secinze di Parigi, 1758. Memoires de l'Académie des Sciences, 1764, page 408, et suiv.

† Transactions Philosophiques, tom. xlviii. partie 1. page 210.

‡ Voyage dans les Alpes, &c. tom. ii. p. 56.

pareil par une nuée orageuse, comme le sont les pointes des girouttes et des mâts, c'est ce qu'ont éprouvé en 1767, M. M. Pictet, de Saussure et Jallabert, fils, sur la cîme du Breven. Le premier de ces sçavans, à mesure qu'il marquoit sur son plan la position de quelque montagne, en demandoit le nom aux guides qu'on avoit pris, et pour la leur désigner, il la montroit du doigt en élevant la main. "Il s'appercut que chaque fois qu'il faisoit ce geste, il sentoit au bout de son doigt une espece de frémissement, ou de picotement, semblable à celui qu'on epreuve lorsque l'on s'approche d'un globe de verre fortement électrisé." L'electricité d'un nuage orageux, qui étoit vis-à-vis fut la cause de cette sensation. L'effet fut le même sur les compagnons et les guides du voyage; et la force de l'electricité augmentant bientôt la sensation produite par l'electricité, devint à chaque instant plus vive, elle étoit même accompagnée d'un espece de sifflement. M. Tallebert, qui avoit un galon à son chapeau, entendoit au tour sa tête un bourdonnement effrayant, que les autres personnes entendirent aussi quand elles mirent ce même chapeau sur les têtes.

On tiroit des etincelles du bouton d'or de ce chapeau, de même que de la virole de métal d'un grand baton. L'orage pouvant devenir dangereux, on descendit à dix ou douze toises plus bas, où on ne sentit plus d'electricitè. Bientôt après il survint une petite pluie, l'orage se dissipa, et on remonta au sommet, où on ne trouva plus aucun signe d'electricité.*—*Berth. Elec. Met.*

P. S. Mr. Howard mentions a luminous appearance in the clouds, on the 31st March, 1812, as "an extensive appearance of light in the clouds to the West, with rapid coruscations passing through them, in the manner of an aurora borealis. This phaenomenon was apparent-

* Voyage dans les Alpes, &c. tom. ii. page 55.—Histoire de l'Académie, 1767, page 33.

ly not more elevated then the cloud then occupying the sky, and was certainly not produced by a light situate below them. It continued twenty or thirty minutes."—*Nickolson's Phil. Jour. March* 1812.

I refer the reader also to various accounts of the Feux St. Elme, and other curious electrical phaenomena, in *Bertholon Elec. Met.* above quoted.

I subjoin the following plan of a more perfect kind of meteorological journal, than I have hitherto observed in common use: in which observations on the instruments of meteorology, &c. should be made several times a day.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A Year, Month, and Day of Observation.	Hour and Minute of Observation.	Height of Thermometer.	Height of Barometer.	State of Hygrometer (Saussure's.)	Degrees of Evaporation since last Observation.	Quantity of Rain fallen since last Observation.	Direction of the Wind.	Directions of Currents above, known by Clouds or Air Balloons.	Force of the Wind, determined by an Anemometer.	Whether the Wind is in Gusts, or moves uniform.	Modifications of Cloud.	General Appearance of the Weather, whether Stormy or Calm, &c.	Whether Lightning, Meteors, Halo, or other occasional Phaenomena.	Indications by Electrometer.	By De Luc's Column.	What Diosemeia, or Prognosticks noticed.	First and latest Appearance of Migratory Birds.	What Diseases of Men, Animals, or Vegetables, most prevalent.

EXPLANATION OF THE PLATES.

Pl. I. Fig. 1. Represents a comoid cirrus. This is the variety called the Mare's Tail.
Fig. 2. A cirrus lengthened out into a long pointed tail, above it is a long straight linear cirrus.
Fig. 3. Are cumuli; others are seen below them in the distance.

Pl. II. Fig. 1. Cirrus beginning to change to the cirrocumulus.
Fig. 2. The cymoid cirrostratus, a stormy feature of the cloud.
Fig. 3. Nascent cumuli forming in the top of the stratus soon after sunrise.
Fig. 4. A fine thin stratus ascending in the morning.

Pl. III. Fig. 1. A cirrocumulus.
Fig. 2. A cirrostratus seen in profile.
Fig. 3. A mottled cirrostratus, there is a cirrocumulative tendency in its burred nebeculae.
Fig. 4. Another long cirrostratus seen in profile in the horizon.

Pl. IV. Fig. 1. Another cirrus figured like the cyma of architecture.
Fig. 2. Lines of cirrostratus.
Fig. 3. The same cloud breaking out into cirrocumulus for being influenced by the cumulostratus below.
Fig. 4. Cumulostratus. Many of the long cirrostrati alight on its summits.

Pl. V. Fig. 1. A nimbus pouring rain.
Fig. 2. The cirrose crown.
Fig. 3. A dense feature of cirrocumulus, often seen before storms.
Fig. 4. Little cumuli entering the storm from below.

Pl. VI. (*Frontispiece*,) Fig. 1. A halo.
Fig. 2. A double halo.
Fig. 3. A discoid or coronoid halo.
Fig. 4. A corona or burr.
Fig. 5. A parhelion.
Fig. 6. A caudate meteor or falling star.

THE END.

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Plate I.

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Plate IV.

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Plate V.

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